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ABSTRACT

These curricular materials are intended to explain wastewater treatment processes, detail the goals of the Boston Harbor Project, and describe the responsibility of individual citizens to the revitalization of Boston Harbor. A series of student activities covers three main topics: wastewater operations, wastewater residuals, and household hazardous waste. Activities are written at a junior high school reading level but can also be adapted for older or younger groups. Each activity features an introduction for the teacher explaining the goals, concepts, materials, and procedures for conducting the lesson. (WRM)

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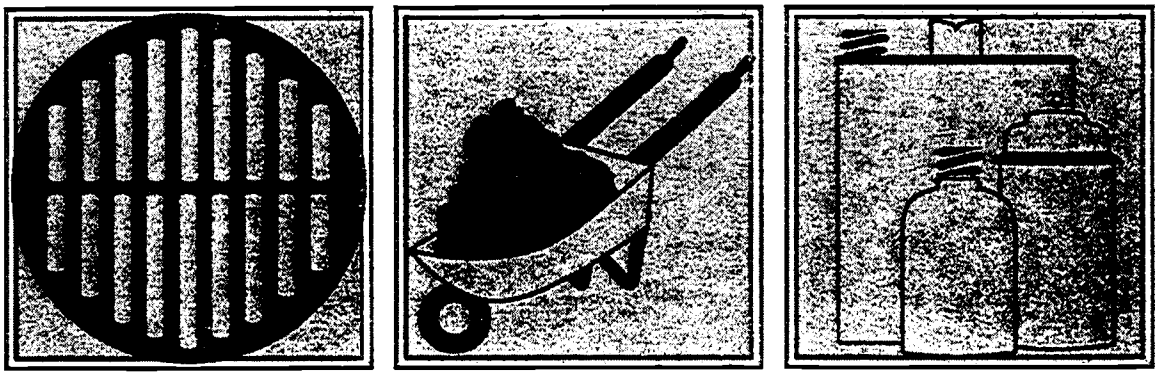
DOWN THE DRAIN



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Preface

Preface

The Massachusetts Water Resources Authority provides wastewater collection and treatment services to more than 2 million people in 43 communities in the Greater Boston area. The MWRA discharges wastewater into Boston Harbor, as have prior agencies and residents of the area since colonial times.

The burden of waste material over the years has contributed to the degradation of Boston Harbor, leading federal regulators to require substantial upgrading of the treatment system. Part of MWRA's mission, when it was created in 1985, was to build a secondary treatment plant and an outfall tunnel for treated effluent, to cease the discharge of sludge by 1991 and to address the problem of combined sewer overflows. The Boston Harbor Project is a huge undertaking, over ten years in planning and construction, with an estimated cost of $7 billion.

Down The Drain is intended to explain wastewater treatment processes, detail the goals of the Boston Harbor Project and describe the responsibility of individual citizens to the revitalization of the harbor environment. The classroom activities in *Down The Drain* are supported by a program of guest speakers and tours of MWRA facilities.

Young people can make a difference, not only in today's effort to reclaim Boston Harbor, but throughout their lifetimes as protectors of the environment. With everyone's help, the harbor can be a vital resource for future generations of Massachusetts citizens.

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PART II: RESIDUALS FROM A WASTEWATER TREATMENT PLANT

5. **Residuals: Deciding what to do**
   A role-playing activity in which students read about different use/disposal options for sludge and then argue for their use/disposal option to be adopted by the "Board of Directors."

6. **Using sludge fertilizer pellets**
   Students learn about the appropriate application rates of fertilizer pellets through three math problem solving activities.

PART III: HOUSEHOLD HAZARDOUS WASTE: WHAT YOU CAN DO TO PROTECT BOSTON HARBOR

7. **What are household hazardous products and household hazardous waste?**
   An introduction to types of hazardous products and their effects. Activities include an introductory question sheet, a reading for basic information and a demonstration of the effects of waste motor oil on the marine environment.

8. **Reading product labels**
   Students learn to interpret the information that manufacturers are required to include on hazardous products.

9. **Home hazardous product survey**
   Students and their families compile an inventory of hazardous products in their homes. They compare their results in class to estimate the total amount of such substances in their community.

10. **Safer alternatives to household hazardous products**
    Students examine advertising for common household products, then learn and try some safer alternatives.

11. **Home Safe! Board game**
    Reinforce facts and concepts from previous sections through a board game available from MWRA.

PART IV: GUEST SPEAKER PROGRAM

As a follow-up to these classroom activities or as an introduction to the subject, speakers from MWRA will visit your school. For best results, please let the speaker know what areas and questions especially interest your students.

PART V: TOURS

As a further follow-up, tours of MWRA facilities can be scheduled through Sewerage Division personnel.

About Down the Drain

About *Down The Drain*

Down The Drain has three components. The most important of them is this curriculum guide for classroom activities. The second, is a guest speaker program. After a speaker has visited your school, you may wish to use the third component, a tour of an MWRA wastewater facility. The contact person for all materials and services is Meg Tabacsko at (617) 242-7310.

1. The curriculum guide is a series of activities on three main topics: wastewater operations, wastewater residuals and household hazardous waste. The activities are written at a junior high reading level, but can be used by older or younger groups as well. Supplementary print materials and videos can be borrowed from MWRA.

Each activity contains an introduction for the teacher explaining the goals, concepts, materials and procedures for conducting the lesson. These teacher pages, with the darker color, are followed by student pages, with the lighter color, containing student readings, question sheets, homework assignments and any other materials to be copied and used in the course of the activity.

Down The Drain is written and arranged so that it can be used front to back as a comprehensive unit on wastewater. We recognize, however, that few teachers have the flexibility to insert such a large body of work into already crowded programs. Therefore, each activity is also intended to stand on its own as a single lesson. Even if you don't have time to teach all of *Down The Drain*, we encourage you to look through the table of contents for an activity or two that appeals to you or that might especially suit your class. You might choose to do the first activity in each major section, to give students the overall picture, and then follow their interests into subsequent activities.

MWRA personnel are available for teacher training sessions to introduce the program. We will demonstrate selected activities and provide additional background information on the Boston Harbor Project. Workshops can vary in length to suit the time available and can be scheduled at your convenience. Also, our library and its staff are available for additional reference and research.

2. Once you have introduced your students to *Down The Drain*, you may wish

to have a guest speaker from MWRA visit your classroom to talk with students about wastewater and Boston Harbor. (We will do our best to fulfill all requests, but at busy times of the year we cannot guarantee that someone will be available). Speakers will be able to make general presentations on the entire topic, or to focus on any portion that especially interests the students. In the latter case, it would be helpful to notify the speaker in advance of the kinds of questions the students have.

3. The third component of the program, after classroom activities and guest speakers, is to tour MWRA wastewater facilities, from a headworks or pumping station in your community to Deer or Nut Island. There may be some time constraints and size limitations, but a trip to a facility can be very educational. In order to get maximum benefit from the time and effort that these tours require, we ask that the class prepare by participating in at least one activity and by inviting a guest speaker before the day of the tour.

Finally, we see *Down The Drain* as an evolving program. We want to expand and improve it wherever we can. We need your help in this endeavor. Please take time to complete the evaluation form to let us know what worked and what didn't, what was helpful and what was inconvenient, as well as ideas of your own that you applied to the lessons. We greatly appreciate your time and trouble to help us improve *Down The Drain.*

Materials Available

MATERIALS AVAILABLE FROM THE MWRA

Brochures for distribution

The following printed material can be supplied to you in any quantity and may be kept by the students:

1. **"How We Operate One of The Oldest Sewer Systems in America"**

2. **"How We Plan to Clean The Dirtiest Harbor in America"**

3. **"Just the Facts"**

4. **Household Hazardous Waste Brochure**

Curriculum Package

Available for classroom use on a *loan basis* is:

1. **Wastewater Curriculum Package from the Water Pollution Control Federation**

Each kit contains **H2O TV: The Wastewater Video** (10:48) designed to generate interest in wastewater treatment using computer graphics and special effects, **20 Student Resource Guides**, intended to build on the interest generated by the video by giving detailed information on wastewater treatment, along with activities to highlight some of the topic's more important points, and a **Teacher Resource Guide**, providing additional background information.

Videos available for loan

1. **"THE BOSTON HARBOR PROJECT"**

An introduction to the MWRA and its water and sewer functions, concentrating on the condition of the harbor, the need to undertake the clean-up and the

expected results. (Boston: Regina Villa Associates for MWRA, 1990, 12 minutes; color)

2. **"DEER ISLAND TOUR"**

A complete tour of the Deer Island Treatment Plant which highlights the present facility, the wastewater treatment process and the plans for the new facility. (Boston: Studio 5 Productions for MWRA, 1989, 11 minutes; color)

3. **"BOSTON HARBOR: REGIONAL RESOURCE AT RISK"**

Introduction to Harbor Pollution: CSOs and wastewater treatment, toxic waste prevention, source reduction and water conservation. (Boston: Sierra Club, 1986, 18 minutes; color)

4. **"THE BATTLE FOR BOSTON HARBOR"**

Survey of problems and suggestions for wise use of water in the future. (Boston: WBZ-TV, 1987, 53 minutes; color)

5. **"NOVA: ARE YOU SWIMMING IN A SEWER?"**

Controversial picture of health, ecological damage and the world coastal water quality problem. It questions the ocean's ability to detoxify and dilute wastes. (Boston: WGBH-TV, 1986, 58 minutes; color)

6. **"SLUDGE PROCESSING"**

Overview of the MWRA's interim and long-term residuals management plan. Information on sludge processing and the goals and benefits of innovative techniques. (Boston: Nesson Media, 1989, 15 minutes; color)

7. **"A FIGHTING CHANCE FOR BOSTON HARBOR"**

Depiction of the pollution problem and action steps to clean up Boston Harbor and ensure the quality of area waters in the future. (Boston: River Run Productions for MWRA, 1988, 21 minutes; color)

Slide Shows

1. **"NATURE'S WAY"**

A look at the wastewater treatment process in relation to nature's own cleaning process. (Eastman Kodak Co. for WPCF, 1983, 80 slides with audio cassette, 10 minutes; color)

2. **"THE WASTE IN WASTEWATER"**

An introductory look at types of residuals and handling options. (MWRA, 1990, includes audio cassette).

3. **"THE SLUDGE IN WASTEWATER"**

A look at watewater sludge, its physical properties, and its potential as a fertilizer and soil conditioner. (MWRA, 1990, includes audio cassette).

Kits

1. **PRESENTATION BOARDS**

Six 30" x 40" laminated roll-up poster boards depicting each step in the wastewater treatment process (part of Lesson 1 or to enhance any of the other lessons).

2. **HOME SAFE! BOARD GAME.**

Includes five Home Safe! Board games, enough to accomodate up to thirty students (Part of Lesson 11).

PART I

INTRODUCTION

INTRODUCTION

One of the benchmarks for any community is the quality of its water resources. "Running water" means, to most people, the availability of potable water at the tap and in urban North America we pretty much take this for granted. But we also must have water running *away* from our homes and communities, to dispose of many kinds of waste common to our daily lives. Whether bathing, cleaning or flushing, we use water to remove waste materials and protect the public health.

Historically, inland communities have relied on lakes and rivers for discharge of wastewater. Rural residents have used ground disposal, burying wastes in the earth. Coastal communities, like Greater Boston, have depended on the ocean and its tides to remove wastewater. In all three cases, nature has accepted organic waste and processed it, recycling it and cleaning the water that we have dirtied. In recent times, treatment systems have been developed to assist nature: septic systems for individual users and treatment plants for communities. In all cases, these systems imitate nature's own methods for purifying water.

Two major factors require us to give nature a helping hand. The first is population density. Rivers can clean wastewater and provide usable fresh water downstream, but only if the *volume* of the waste is small enough and the distance to the next community great enough. Septic systems can digest waste and return water to the ground through leaching fields, but each system has finite capacity. Boston Harbor and Massachusetts Bay can process a great deal of waste, but the population of this area long ago overwhelmed the harbor's ability both to process waste and to maintain its health as a marine estuary, a fertile mixing ground of salt and fresh water.

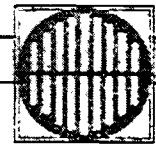
The second factor confronting communities today is the *content* of wastewater from industrial societies. As chemistry has improved our lives, it has also threatened the environment of our receiving waters. Complex solvents, pesticides, oil and heavy metals degrade slowly or not at all. They can accumulate in sediments, migrate up the food chain and ultimately jeopardize the health of all organisms along the way. Human beings, at the top of the ladder, can be at great risk from biomagnification of toxic material.

Since the earliest days of European settlement, residents of the Boston area have depended on Boston Harbor, and the rivers and streams feeding it, to drain and clean the community. Storm water must be channeled away from buildings and by-ways and the wastes of daily human activity must be removed to prevent discomfort and disease. From the Seventeenth into the Nineteenth Century, the tides were adequate to the task. But as the population grew, conditions became less tolerable. Consider this report from the State Board of Health in 1876:

> "Complaint of bad odors have been made more frequently during the past year than ever before. Large territories have been at once, and frequently enveloped in the atmosphere of stench so strong as to arouse the sleeping, terrify the weak, and nauseate and exasperate everybody.
> It has been noticed more in the evening and by night than during the day; although there is no time in the whole day when it may not come. It visits the rich and poor alike. It fills the sickchamber and the office. Distance seems to lend but little protection. It travels in a belt half-way across the city, and at that distance seems to have lost none of its potency, and, although its source is miles away, you feel sure it is directly at your feet. The sewers and sewage flats in and about the city furnish nine tenths of all the stenches complained of. They are much worse each succeeding year; they will be much worse next year than this."

Such intolerable conditions, combined with the emerging understanding of the microbiological causes of disease, meant that some solution to Boston's drainage problems must be found.

In the 1870s, the area was served by numerous individual drains and trenches leading from higher ground to the nearest river, stream or shore. The original purpose of these drains was to carry storm water, but as water supplies had improved in the early 1800s and flush toilets came into use, they also carried sanitary waste. (Combined sewerage, as this is called, began in the 1830s and continues in parts of the area today.) As tide flats were filled and the city grew, the drains carried wastewater at shallower pitches. Increasing volumes moved ever more slowly, even backing up at high tide, causing the stench noted by the Board of Health.



Three major drainage projects were conceived to address the problem, consisting of large underground sewers to intercept the individual drains along the shore and pumping stations to force wastewater further away from shore where it could be mixed directly with the tides. Boston Main Drainage, built between 1876 and 1884, discharged at Moon Island; the North Metropolitan System was begun in 1889 and finished in 1895, discharging at Deer Island in Winthrop; and the Neponset River Valley System, completed between 1895 and 1904, discharged at Quincy's Nut Island. In 1942 Boston Main Drainage was connected by tunnel to Deer Island, eliminating daily discharge at Moon Island.

For decades, these systems simply discharged untreated wastewater. The first upgrading of the original system came with construction of a primary treatment facility at Nut Island in 1952 and another at Deer Island in 1968. However, even with those improvements, heavy rainfall overloads these facilities and untreated wastewater is released directly to Boston Harbor. This is the system Boston relies on to this day.

The Federal Clean Water Act now mandates secondary treatment and EPA rulings require construction of an outfall tunnel for wastewater effluent (the "cleaned" water from the plant) to extend nine miles into Massachusetts Bay. Nut Island in Quincy will cease to be a treatment point, but will be connected by a tunnel to Deer Island, where one large secondary facility will be constructed. (The project is described in more detail in Part I of *Down The Drain.*) The major changes in the 1990s will be the most significant upgrading of the system since its construction a century ago.

Why should students learn about wastewater treatment and the Boston Harbor Project? For several reasons. First, a great deal of money is being invested in this infrastructure improvement; we all are owners of the facilities, and we all should understand what they are and how they work. Second, the problem of waste disposal goes beyond wastewater. The lessons of this pollution crisis will help informed citizens to understand and resolve related solid and hazardous waste issues. Finally, as consumers of wastewater services, there are habits we all can change that will protect this major investment in our environment. *Down The Drain* is intended to meet all three of these goals.

Teachers are the key link between the MWRA and the students of Greater Boston. These materials present concepts that are crucial to their environmental awareness and attitudes. We rely on you to convey the message that they can make a difference today and tomorrow.

Lesson 1

Drawing on Collective Wisdom

Purpose:

To introduce students to the basics of wastewater treatment and to impress upon them that they are personally involved.

Lesson in brief

Students learn about wastewater and where it goes when it leaves our homes. Through follow-up materials they learn the basic processes of wastewater treatment.

Key words and concepts

Water is used to remove waste from our homes and communities through a wastewater system.

Wastewater must be treated before it is returned to the environment, to minimize its harmful effects.

Aeration	Grit Chamber	Sedimentation	Wastewater
Bar Screens	Primary Treatment	Separate Sewers	
Combined Sewers	Scum	Sludge	
Disinfection	Secondary Treatment	Storm Sewers	

Materials

Chalkboard or mural size paper and markers and "How We Plan to Clean the Dirtiest Harbor in America."

Time required

One class period.

Preparation

To obtain student copies of "How We Plan to Clean the Dirtiest Harbor in America" or to borrow a set of wastewater treatment process presentation boards, call Meg Tabacsko at (617) 242-7310.

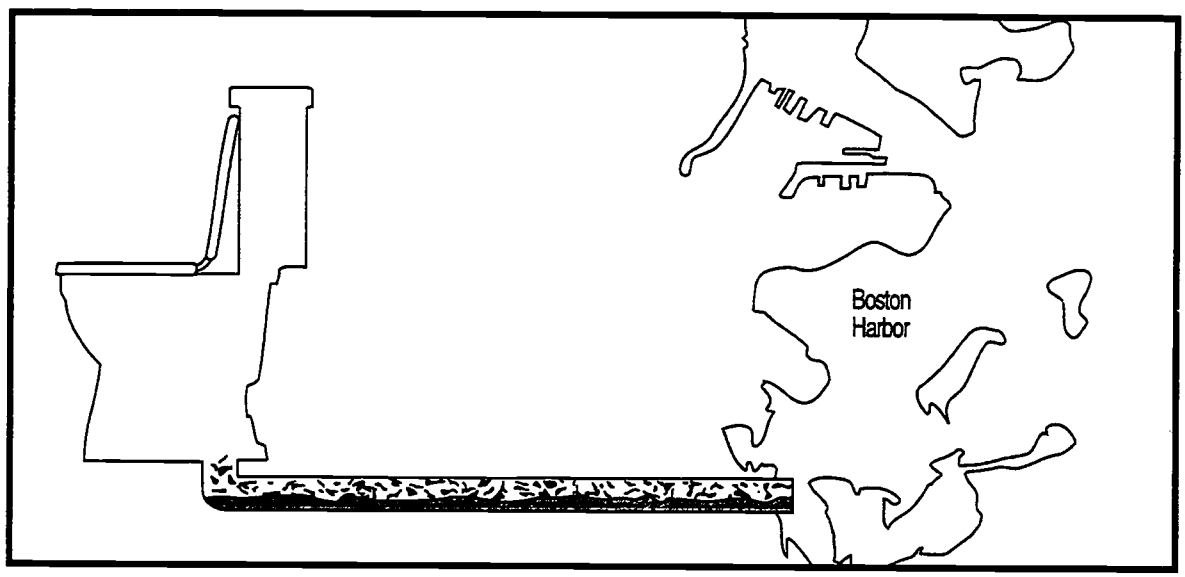
Procedure

Day 1:

1. Ask students what they have heard about Boston Harbor. (Answers tend to be negative: it's polluted, it's disgusting, it's too dirty to swim in, etc.) Let the students know that even though parts of the harbor are polluted, there is still a lot of life in Boston Harbor.

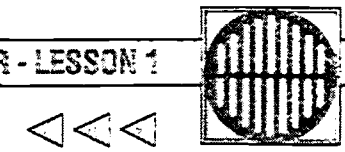
2. Ask students to name some things that live in Boston Harbor and/or Massachusetts Bay. Create a mini-harbor on one side of the board by having the students who name plants and animals come up and draw them. Seek diversity: fish, lobsters, plankton, birds, seals, seaweed and other plant life.

3. Ask for a volunteer artist and have him/her draw a toilet on the other side of the board. (Expect laughter at this request.)



4. Ask the class why you had them draw the harbor on one side and a toilet on the other. What is the connection between a toilet and Boston Harbor? Someone may know, or may guess, that their toilets eventually drain to Boston Harbor.

5. Explain that every time a toilet is flushed in one of the 43 communities which make up the MWRA district that the wastewater eventually ends up in Boston Harbor. Explain that wastewater = water + anything else



you add to it and then dispose of. In the case of a toilet, water + human waste = wastewater. But human waste is not the only thing that is flushed down a toilet. Ask the students what else they have (or know someone else has) flushed down a toilet. List the answers on the board. Examples are, toilet paper, dead fish, food, cigarette butts, cleaning chemicals, etc.

6. Ask the students to name some of the other places in their homes where wastewater is produced and list the answers on the board. Examples are: showers, where wastewater could be water + hair, soap, dirt, germs, etc.; kitchen sinks, water + food, grease, detergent, etc.; washing machines, water + bleach, pieces of fabric, etc.

7. Draw a pipe from the back of the toilet and explain that wherever wastewater is produced, it has to have some sort of pipe so that it can leave the house. These small pipes, leading out of buildings, connect into bigger sewer pipes under the streets that are maintained by each city or town, which in turn feed into MWRA pipes, which eventually lead to Boston Harbor.

8. Have this last pipe stop just short of the harbor. Tell the students that the wastewater stops somewhere before it goes into the harbor. Ask the students if they know where it stops or what is done to the wastewater before it is discharged into the harbor. Explain that the wastewater goes to a wastewater treatment plant (Deer or Nut Islands) to be "cleaned" before it is discharged into the harbor.

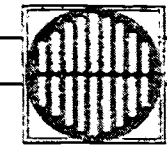
9. Before explaining the treatment process, ask the students where else might wastewater be produced. (Any place where water is used and disposed of is an acceptable answer.) Examples are, schools, hospitals, industries, restaurants, etc.

10. Explain that wastewater is not only produced "inside", but also "outside". When it rains or a hose is used, this is also considered wastewater. This wastewater goes down the storm drains you see on the side of the road. Draw a storm drain and ask what are some of the things that would make up this wastewater. Water + rocks, cans, candy wrappers, oil, fertilizer, money, etc.

11. Explain that the different storm drains also connect into sewer pipes under the streets. Ask where this wastewater goes. Does it go to the treatment plant? In most cases the answer is no! All the communities within the MWRA district (except for Boston, Cambridge, Somerville and Chelsea) have what are known as "separate sewers". Wastewater from buildings travel in sewer pipes which go to the treatment plant to be "cleaned" before being discharged into the harbor. The wastewater from the side of the road travels in the "storm sewers" to some local body of water and eventually, in our area, to Boston Harbor. It does not get "cleaned"!

12. Explain that Boston, Cambridge, Somerville and Chelsea are "combined sewer" communities. They only have one set of pipes for the all wastewater that is produced inside and outside. In most cases, the wastewater from combined sewers travels to the treatment plant. In the case of heavy rainfall, the sewers can't handle the additional flow. Instead of having the wastewater back up into people's homes and other buildings or into the street, the wastewater is released directly into the harbor or the Charles, Mystic or Neponset Rivers. (Lesson 3 is about the combined sewer overflow, or CSO, problem.)

13. Explain the wastewater treatment process using the presentation boards or photo copy the pages depicting each of the steps. You may want to ask the students if they can guess the correct order of processes. As you describe each step, have the students list some of the components of the wastewater that would be "cleaned" out at that particular step.



SEQUENCE OF PRIMARY TREATMENT

BAR SCREENS: The bars screens are between 3/4 of an inch and 3 inches apart. The wastewater is allowed to flow through, but large objects, such as rocks, sticks, cans, rags, etc. are stopped.

GRIT CHAMBERS: This is where the flow of the wastewater is slowed, so that heavy, solid objects that were small enough to get through the bar screens, such as pebbles, coffee grounds, jewelry, coins, etc. can settle to the bottom.

(The solid material taken from the wastewater during these two processes are referred to as **GRIT & SCREENINGS**, which are collected, hauled off site and landfilled.)

PRIMARY SEDIMENTATION TANKS: In these tanks, the flow of the wastewater is again slowed to allow heavy organic solids to settle to the bottom and light floatable objects to rise to the top. The material that settles to the bottom such as human waste and chemicals is referred to as **SLUDGE** and the material that rises to the top, such as fats, oil, grease, small bits of plastic, is referred to as **SCUM**.

(Beginning in January 1992, the **SLUDGE & SCUM** will be mixed together and recycled into fertilizer pellets. Prior to this, **SLUDGE** had been discharged into the harbor with the out going tide every day. The practice of ocean dumping **SCUM** ceased in 1988. Scum has been mixed with a cement kiln dust which is landfilled and used for landform on Deer Island.)

DISINFECTION: Sodium hypochlorite is added to the wastewater to kill any disease-causing organisms before discharging the EFFLUENT into Boston Harbor.

SEQUENCE OF SECONDARY TREATMENT

BAR SCREENS: Same as primary treatment.

GRIT CHAMBERS: Same as primary treatment.

PRIMARY SEDIMENTATION TANKS: Same as primary treatment.

AERATION TANKS: Air and oxygen are added to the wastewater, stimulating the growth of beneficial or "good" bacteria, which multiply and consume remaining waste material and "bad" bacteria still present in the wastewater.

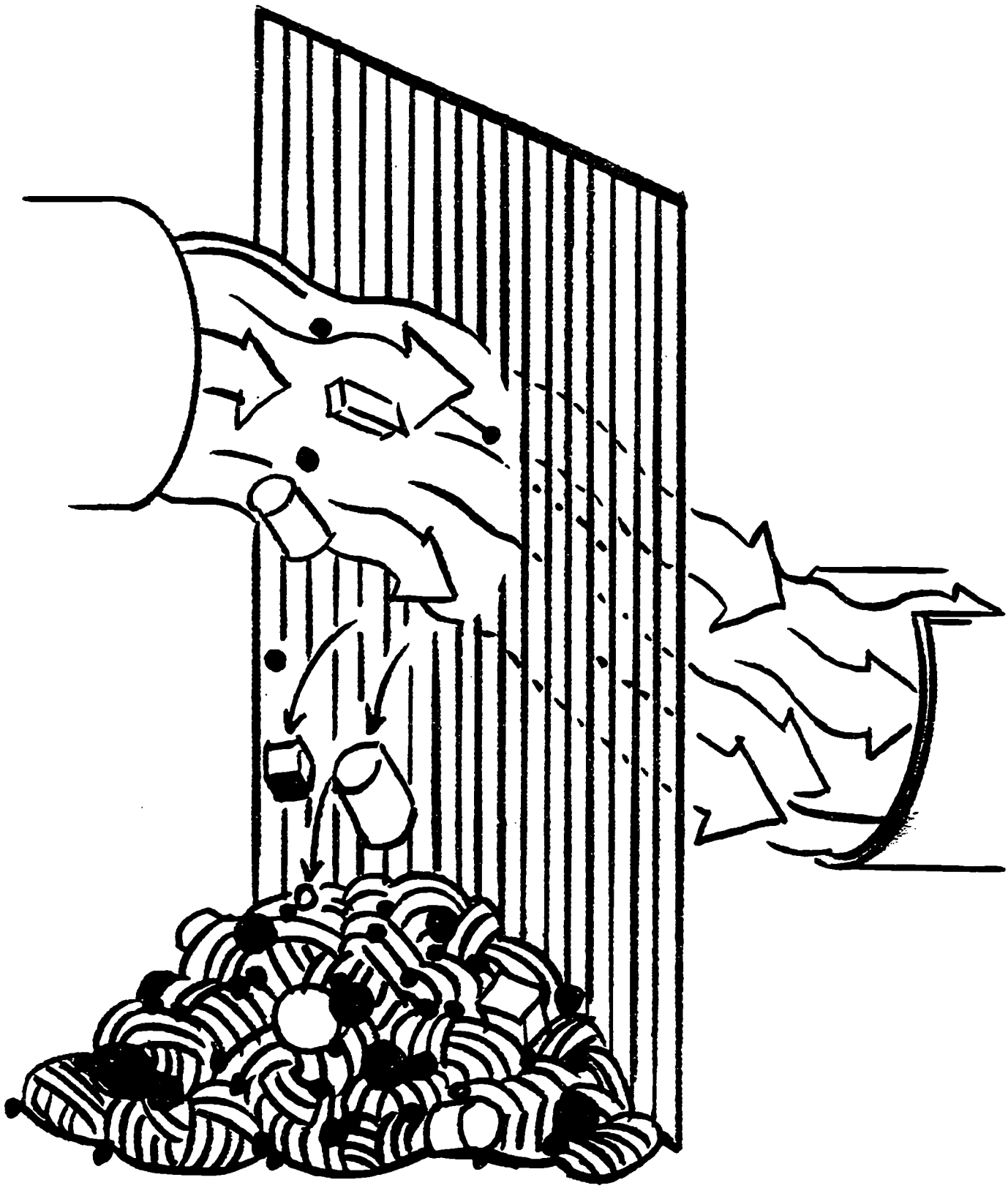
SECONDARY SEDIMENTATION TANKS: Micro-organisms and solid material from the aeration process clump together and settle to the bottom. This is referred to as **SECONDARY SLUDGE**.

DISINFECTION: Same as primary treatment.

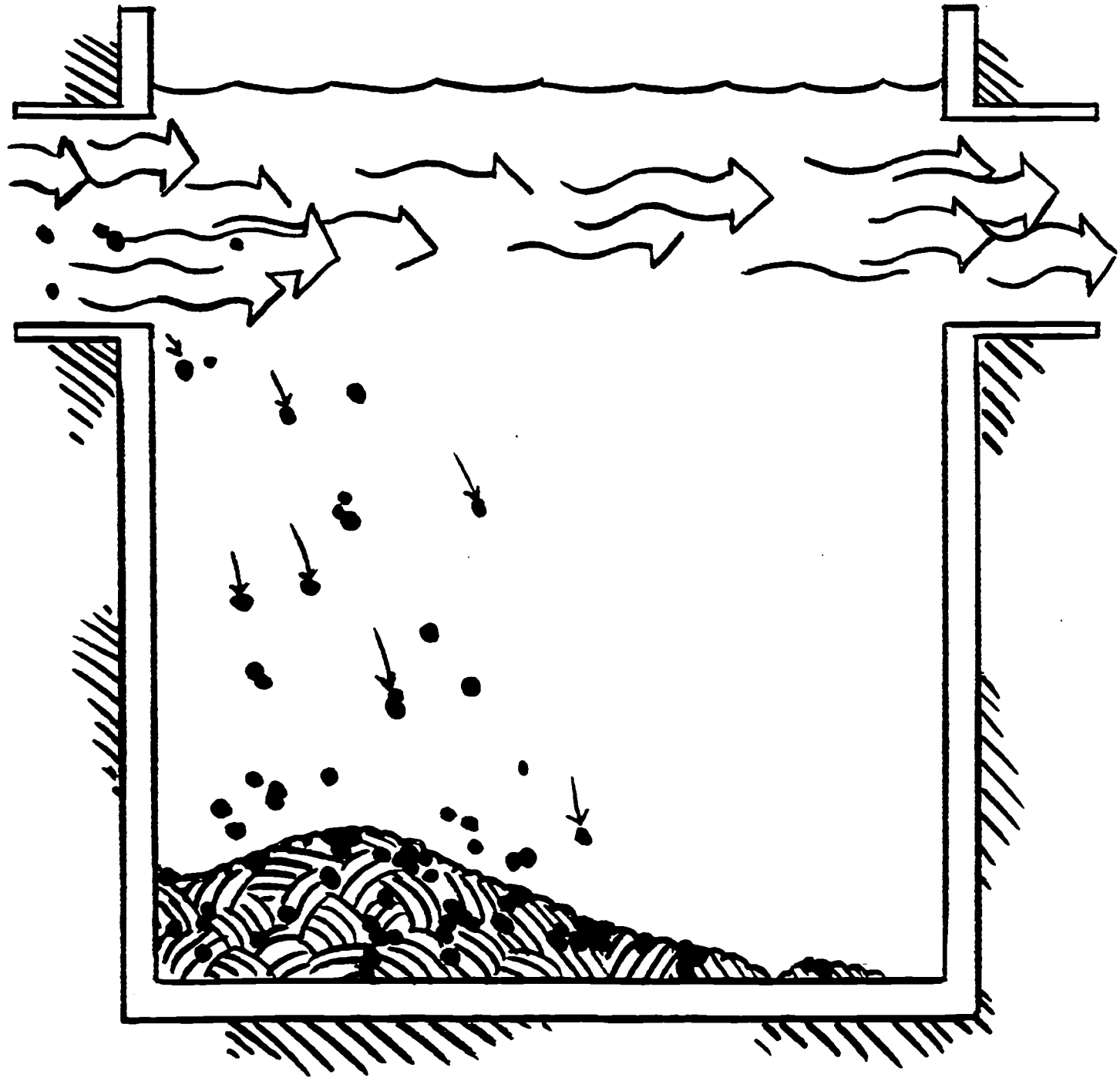
14. Ask the students what level of treatment they think the wastewater in the MWRA district receives. They may be surprised to learn that full secondary treatment will not be in operation until 1999.

15. Distribute copies of "How We Plan to Clean The Dirtiest Harbor in America", if time permits, have them complete the question sheet in class. If not, have them read the brochure and complete the quiz as a homework assignment.

Drawing on Collective Wisdom

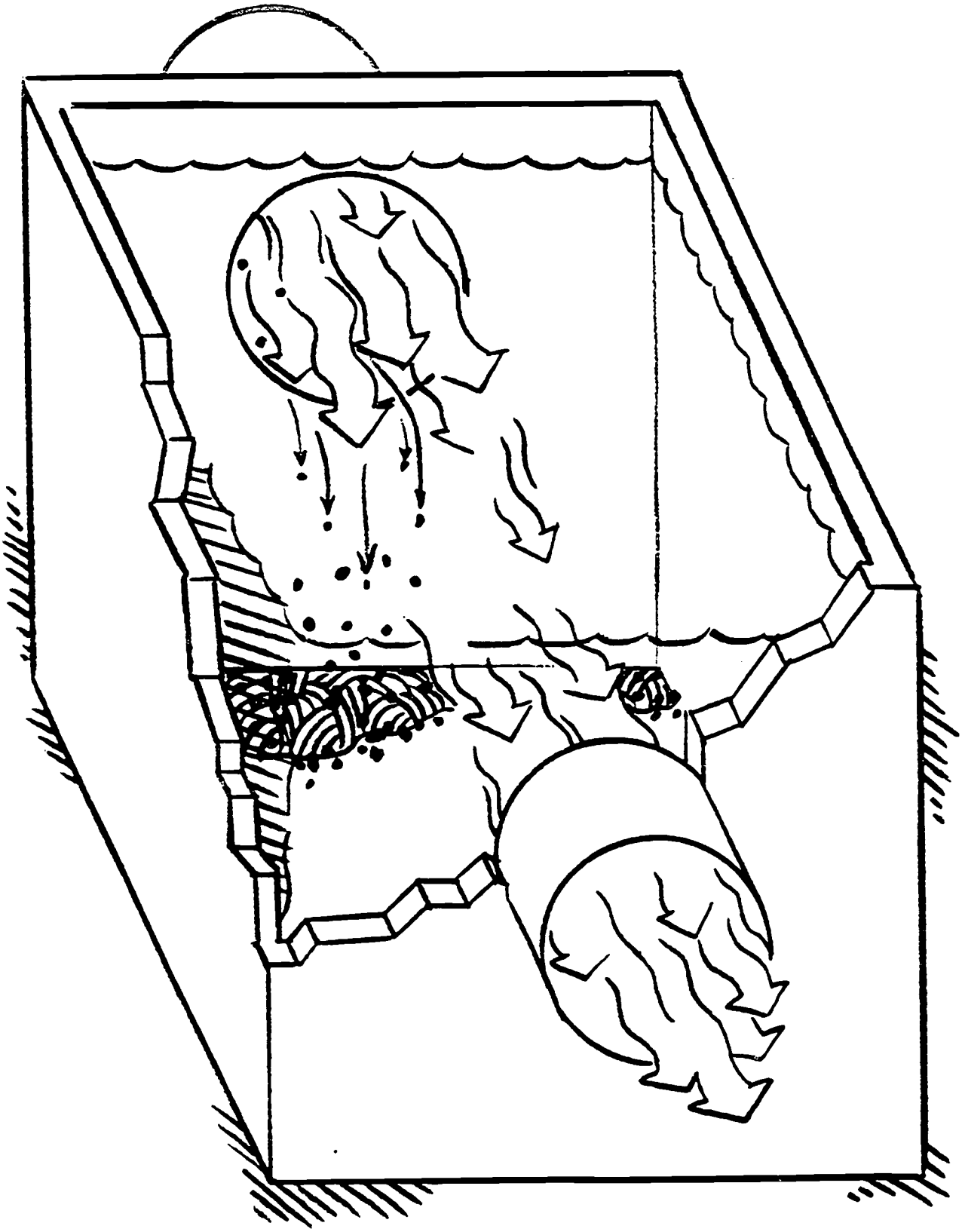


Bar Screens



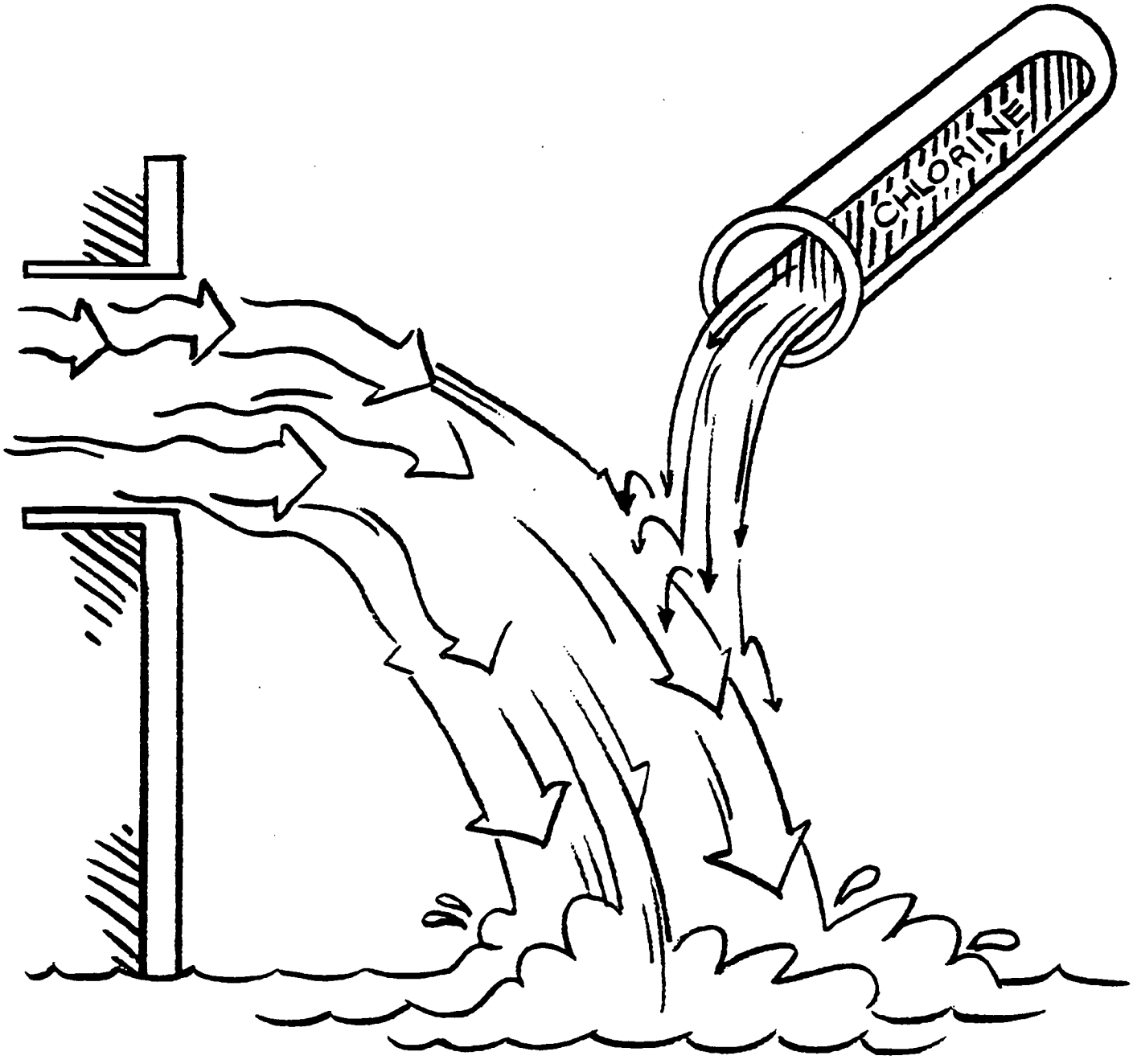
Grit Chamber

Drawing on Collective Wisdom



Secondary Sedimentation Tank

Drawing on Collective Wisdom



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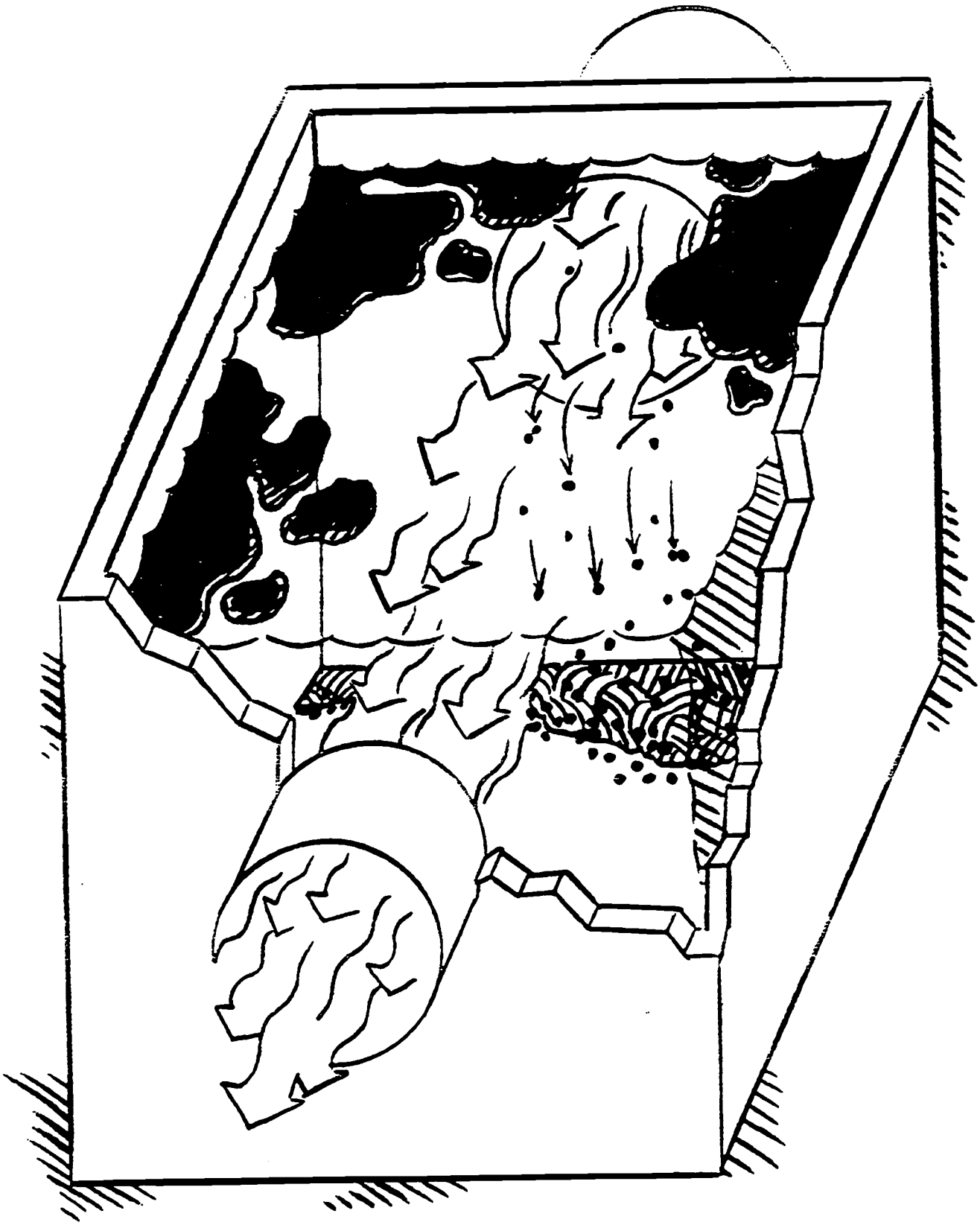
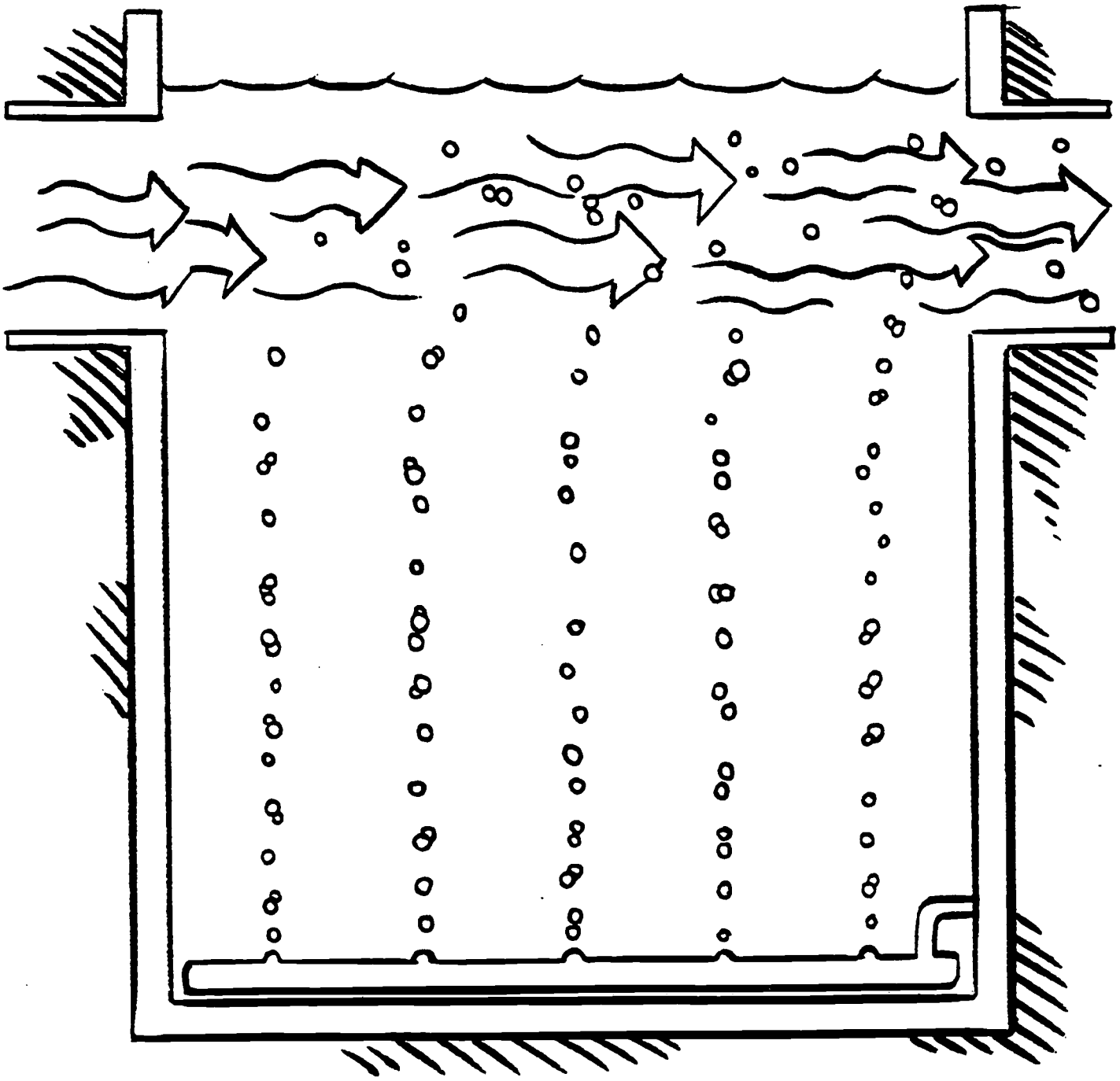
Disinfection

Drawing on Collective Wisdom



Primary Sedimentation Tank



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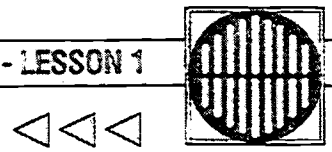
Aeration Tank



(Answer sheet)

Fill in the blanks:

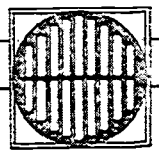
1. Two U.S. cities that have used secondary treatment since the 1920s are ***Chicago*** and ***Milwaukee***.
2. Three rivers that empty into Boston Harbor are the ***Charles, Neponset*** and ***Mystic***
3. The Boston Harbor Project is estimated to take ***eleven*** years to complete.
4. The new Inter-Island Tunnel between Nut Island and Deer Island is expected to be completed in the year ***1994***.
5. CSO stands for ***combined sewer overflow.***
6. Sludge is ***ninety-seven*** % water.
7. Sewage is currently processed on ***Nut Island*** in Quincy and ***Deer Island*** in Winthrop.
8. Used motor oil, pesticides, paints and solvents are considered ***household hazardous*** wastes.
9. The four options available for sludge management after dewatering are ***composting, landfilling, burning*** and ***making into fertilizer.***
10. During secondary treatment, ***air/oxygen*** is added to wastewater to speed up the growth of microorganisms.

Multiple Choice

1. ***D. 500 million***
2. ***C. Combined Sewers***
3. ***B. Source Reduction***
4. ***A. 1999***
5. ***A. 400 ft. below sea level and 24 ft. in diameter***
6. ***D. All of the above***
7. ***A. 43***
8. ***D. Nearly twice the size of the Boston Common***
9. ***D. All of the above***
10. ***B. Primary Treatment***

Match Column A with Column B

1. Sludge ***E***
2. Groundwater ***D***
3. Headworks ***A***
4. Grit Chamber ***C***
5. Disinfection ***B***



Fill in the blanks:

1. Two U.S cities that have used secondary treatment since the 1920s are_____ and_____ .
2. Three rivers that empty into Boston Harbor are the_____ ,_____, and_____.
3. The Boston Harbor Project is estimated to take_____years to complete.
4. The new Inter-Island Tunnel between Nut Island and Deer Island is expected to be completed in the year_____.
5. CSO stands for_____.
6. Sludge is_____ % water.
7. Sewage is currently processed on_____ in Quincy and_____ in Winthrop.
8. Used motor oil, pesticides, paints and solvents are considered_____ wastes.
9. The four options available for sludge management after dewatering are_____ ,_____, _____and_____ .
10. During secondary treatment,_____is added to wastewater to speed up the growth of micro-organisms.

Multiple Choice

1. Approximately how many gallons of sewage pour into Boston Harbor daily?
   A. 500 C. 1 million
   B. 50 thousand D. 500 million

2. Sewers that carry both street runoff as well as sewage are called:
   A. Combination Sewers C. Combined Sewers
   B. CSO D. Secondary Sewers

3. When a company uses less toxic materials in its manufacturing process or changes its processes to use less of a chemical, this is called:
   A. Toxic Control C. Toxic Reduction
   B. Source Reduction D. Source Control

4. Full secondary operation is scheduled to begin in:
   A. 1999
   B. 1995
   C. 1996
   D. 2000

5. The effluent tunnel planned for Deer Island will be how many feet below sea level and how large in diameter:
   A. 400 ft. below sea level and 24 ft. in diameter
   B. 24 ft. below sea level and 400 ft. in diameter
   C. 200-300 ft. below sea level and 24 ft. in diameter
   D. 200-300 ft. below sea level and 11 ft. in diameter

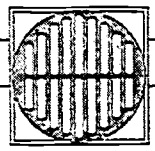
6. Rock boring will be used to build the effluent tunnel because it:
   A. Avoids interference with shipping
   B. Minimizes the impact on marine life
   C. Is the least expensive way to build the tunnel
   D. All of the above

7. The number of communities that receive sewer service from the MWRA is:
   A. 43
   B. 46
   C. 60
   D. 52

8. The new primary and secondary treatment plants on Deer Island will occupy a space:
   A. About the size of the Boston Common
   B. Nearly twice the size of the Boston Garden
   C. About one half the size of the Boston Common
   D. Nearly twice the size of the Boston Common

9. The mission of the MWRA is to:
   A. Modernize the area's Sewerage System
   B. Conserve water resources
   C. Improve the water quality of Boston Harbor
   D. All of the above

10. The level of treatment presently provided at Deer Island is:
    A. Secondary Treatment
    B. Primary Treatment
    C. Primary & Secondary Treatment
    D. Advanced Treatment



Match Column A with Column B

	Column A	Column B
1.	Sludge ____	A. Facility where bricks, logs and other large objects are screened out of wastewater.
2.	Groundwater ____	B. Process of killing bacteria in wastewater before it is discharged into Boston Harbor.
3.	Headworks ____	C. A tank where mud and sand settle out of wastewater.
4.	Grit Chamber ____	D. Flow that enters the sewage system through leaks and that accounts for almost one half of the water reaching the treatment plant.
5.	Disinfection ____	E. The principal by-product of wastewater.

Essay Questions: Write a brief paragraph to answer each question.

1. Explain primary and secondary treatment. How are they different? How are they similar?

2. What is nature's role in the revitalizaton of Boston Harbor ?

3. How did Boston Harbor get polluted?

Lesson 2

Lesson 2 - Who Dirtied Boston Harbor

Purpose:

To attempt to show students how we are all responsible for the present condition of Boston Harbor.

Lesson in brief

Divide the class into groups and distribute 11 canisters among them. Each canister is labeled with a source of wastewater that has contributed to the present condition of Boston Harbor. The students are called up during the exercise to dump their canisters into the water.

Key words

Boston Harbor	Pollution	Scum	Wastewater
Discharge	Receiving Waters	Sedimentation	
Effluent	Runoff	Sludge	

Materials

One large, clear glass or plastic container, such as a gallon jar, a punch bowl or an aquarium containing clean water.

Eleven 35mm-film canisters or other small opaque containers:

1. One container filled with dirt, sand, salt and pebbles labeled "EARTH" to represent soil runoff.
2. One container filled with leaves and twigs labeled "NATURE" to represent natural debris.
3. One container filled with bits of plastic, paper and food labeled "BEACH GOERS" to represent litter.
4. One container filled with cooking oil labeled "MOTOR BOATERS" to represent oil and gasoline from motor boats.
5. One container filled with aluminum foil labeled "PARTIERS" to represent trash and soda cans.
6. One container filled with cocoa or corn starch mixed with instant coffee labeled "INDUSTRIES" to represent wastewater discharge from industries.
7. One container filled with hair and liquid soap labeled "HOME OWNER-1" to represent the shower.
8. One container filled with oil and food particles labeled "HOME OWNER-2" to represent the kitchen sink.
9. One container filled with dirt and detergent labeled "HOME OWNER-3" to represent a washing machine.

10. One container filled with rabbit food pellets and bits of tissue labeled "HOME OWNER-4" to represent a toilet.
11. One container filled with baking soda labeled "HOME OWNER-5" to represent household cleansers.

Time required

One class period for the basic activity (Day 1). The exercise can be extended to a second day.

Background

Waste gets into Boston Harbor in a number of ways. Boston Harbor is the receiving water for 43 communities in and around Boston. Homes, industries, schools and so forth discharge their wastewater through city or town sewers to Deer or Nut Island for treatment and then it is released into Boston Harbor. Rocks, sticks and salt from the road are washed down drains on the side of the road and released into the harbor. People throw cans and trash into the harbor from the shores and from boats. Boats release gas and oil into the harbor. Chemicals get into the sewer system from industries and homes and are released into Boston Harbor.

Procedure

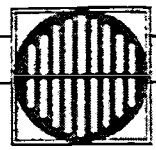
Day 1:

1. Divide the class into groups and pass out the 11 canisters among them.

2. Place the container of clean water where it can easily be seen and is easily accessible by the students.

3. Explain to the students that this is Boston Harbor hundreds and hundreds of years ago before it was labeled "The Dirtiest Harbor in America."

4. Begin asking the following questions...
   Who would like to live on the shores of the harbor?
   Who would swim in the harbor?
   If you got some of this water in your mouth, would you be terribly concerned?
   Who would like to go for a boat ride on the harbor?
   Would you fish in the harbor?
   If you caught fish, would you eat them?



NOTE: This activity can easily be adapted to any body of water, fresh or salt. If you were talking about a body of fresh water you would ask, "Would you drink this water?" It is suggested that you do ask this question and listen carefully for responses. We have found that many people don't know or haven't given any thought to the fact that Boston Harbor is salt water. Salt water is not used as drinking water and contains so much salt (35,000 parts per million) that it poisons land plants and animals instead of nourishing them.

We have heard comments, after talking with students about wastewater and its treatment process, such as "I'll never drink water again!" This is a good opportunity to clear up any misconceptions your students may have.

5. It is raining. Salt, sand, dirt and pebbles are being washed down the storm drains. Who is "EARTH"? The students with the canister labeled "EARTH" release the contents into Boston Harbor.

   Would you still like to live on the shores of the harbor?
   Would you want to swim in the harbor now?
   Would you still go for boat rides on the harbor?
   Would you fish here? Would you eat the fish?
   Would you panic if you got a mouthful of this water?

"NATURE" adds things to Boston Harbor. Leaves are blown into the water. Who is "NATURE"?

Repeat the questions.

Boston Harbor has a number of beaches. People come to the shores to swim, sunbathe and picnic. Who are the "BEACH GOERS"?

Repeat the questions.

Boston Harbor is a wonderful place for recreational activities. The harbor is also used for commerce, as boats transport goods into the city. "BOATERS" use the harbor daily. Who are the "BOATERS"?

Repeat the questions.

Sometimes there are parties on boats and on the shores. People are often careless with trash, and others deliberately throw trash overboard. Who are the "PARTIERS"?

Repeat the questions.

"INDUSTRIES" throughout the MWRA district discharge waste into the sewer system which eventually ends up in the harbor. Who are the "INDUSTRIES"?

Repeat the questions.

Ask the students, "Have you every done any of these things that have contributed to the pollution of the harbor? Who has ever gone on a boat ride in the harbor? Who has ever let trash get into the water, either directly or indirectly?"

Who took a shower this morning? What went down the drain with the water? Who are "HOME OWNERS-1"?

Repeat the questions.

Who ate breakfast this morning and didn't finish everything? Did you put some food in the sink, down the drain? Who are "HOME OWNERS-2"?

Repeat the questions.

The clothes you're wearing are clean. How did they get that way? What mixes with the water in the washing machine before it leaves your house? Who are "HOME OWNERS-3"?

Repeat the questions.

When we flush a toilet, the waste doesn't just disappear. The wastewater is destined for Boston Harbor. Who are "HOME OWNERS-4"?

Repeat the questions.

We all clean our homes. Some household cleaners, such as furniture polish, tub and tile cleaners and so forth, contain chemicals. Who are "HOME OWNERS-5"?

Repeat the questions.

Discussion

Who dirtied the harbor?

Who should clean it up?

Continue to discuss how the harbor got so dirty and who was responsible. Ask the students if they have ever seen any of these kinds of pollution.

Can the harbor be cleaned up? While some of these pollutants come directly into the harbor, many enter by way of the wastewater stream. The treatment plant at the end of the sewer system gives us a chance to clean up the water before it is discharged. How much cleaner the water becomes depends on the level of technology applied in treating it.

How can the water in this bowl be cleaned up? Notice some materials are

floating on the top of the water and other particles have sunk to the bottom. The material on the top is referred to as SCUM and the material which has settled to the bottom is referred to as SLUDGE. The longer you wait, more particles will settle to the bottom. This is a process in wastewater treatment known as SEDIMENTATION. The cleaner water is called EFFLUENT.

If this is a one-day exercise, let students discuss how the model should be disassembled. Our suggestion: (1) Skim the floatables off the top and put them in the trash. (2) Carefully pour the effluent down the drain. (3) Then remove the sludge from the bottom and dispose of in the trash.

If this is a two-day activity, then do not dispose of the dirty water. Set it aside for the next day.

Day 2:

Purpose:

To leave students on a positive note and to reinforce the concepts of wastewater treatment.

Lesson in brief

By "disassembling" the previous day's demonstration, the students will practice wastewater treatment.

Materials

Jar or bowls of various sizes, fish net, spatula, spoons, squares of wire screen, cheese cloth, funnels, paper towels.

Time required

One class period.

Procedure

1. Call attention to the "Dirty Harbor" from the previous day. It should be accessible to the students.

2. Does the water look any different than it did yesterday?
   Has more material settled to the bottom?

What is this process called when wastewater is allowed to sit undisturbed so that particles can settle to the bottom? (Sedimentation)
What is this material on the bottom called? (Sludge)
Who remembers what the material which floats to the top is called? (Scum)

3. Ask the students for suggestions as to how the scum could be removed. When a student comes up with a suggestion, have him/her try it. One possibility -- skimming the scum off the top with a spatula. Scum is made up of fats, oil and grease. A student may suggest using a paper towel to soak up some of the scum.

4. Ask the students for suggestions as to how the sludge could be removed. Could spoons be used to scoop up some of the sludge from the bottom? Would straining the water through cheese cloth or screens trap the sludge? Can they push the sludge to one end of the tank to make it easier to collect? If you pour effluent off, have another container to collect it.

Discussion

When the students have finished with their "clean-up," discuss their success. Is the water clean? Cleaner than the previous day?

What other procedures or equipment might have been helpful? If given more time to settle, could you have gotten the water cleaner? Even if you got the water to look clean, would it really be clean? What impurities might still remain and how could they be removed? How does this compare to the task of treating the almost 500 million gallons of wastewater a day which flow through the MWRA district?

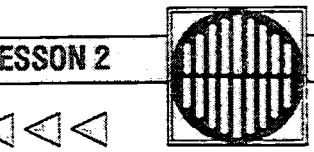
Conclusion

It's not easy to clean the water once it is polluted.

Discuss what each student can do to help the situation. Here are some suggestions:

(1) Water conservation - The less water we waste, the less that has to go through the wastewater treatment process. Discuss water conservation tips. Take shorter showers; don't use the toilet as a waste basket; run the dishwasher and washing machine only when they are full.

(2) Don't litter - Whether or not you live in a combined sewer community, any litter that enters a storm drain goes into some body of water. Discuss the ways

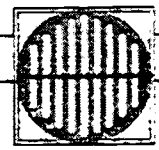


litter gets into the sewerage system and waterways. Rain washes trash from the street down drains. People kick cans and bottles down storm drains. What kind of materials make up this trash?

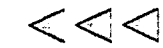
(3) Household hazardous products - Dispose of products properly. Paints, oil or cleaning products containing hazardous chemicals should not be put down the drain. Try to find safer alternatives to hazardous products.

(4) Become informed - The Boston Harbor Project affects everyone who lives or works in the MWRA district. Learn the facts. Find out how your community is affected and what it is doing. Become involved.

Lesson 3



Combined Sewer Overflow



Purpose:

To introduce students to combined sewers and combined sewer overflows (CSOs) and demonstrate how, when and why they are activated.

Lesson in brief

A discussion about separate and combined sewer systems is initiated. Then students walk along boards which represent pipes, carrying styrofoam bits which represent wastewater to demonstrate how the system gets backed up and how wastewater must be released untreated into receiving waters.

Key words

Combined Sewers	Raw Sewage	Separate Sewers
Combined Sewer Overflows (CSOs)	Runoff	Storm Drains

Materials

A piece of wood or strips of paper about 5 feet long.
Three pieces of wood or strips of paper about 2 feet long.
Box of styrofoam packing bits, bag of shelled peanuts or shredded paper.

Time required

One class period. This activity requires some set-up and clean-up.

Preparation

Read the CSO background information to familiarize yourself with combined sewer overflows.

Procedure

Day 1:

1. Review the sources of wastewater with students - Lessons 1 and 2 - and list their responses on the board. (For example: hair, dirt, and soap come from showers; food scraps, oil and dish detergent go down kitchen drains, and so forth.)

2. Introduce the subject of storm drains. What makes up the wastewater that goes down the storm drains? (Rainwater mixes with pebbles, leaves and sticks and goes down the drain. Melted snow mixes with salt, sand and dirt and goes down the drain. People wash their cars and the soapy water runs down the storm drain. Lawn fertilizer and animal waste often enter the sewer system through storm drains. Write these responses in another column on the board.

3. Label the first set of responses INSIDE DRAINS and the second set of responses OUTSIDE DRAINS. We know that the wastewater from the inside drains travels to the treatment plant to be processed before being discharged into Boston Harbor.

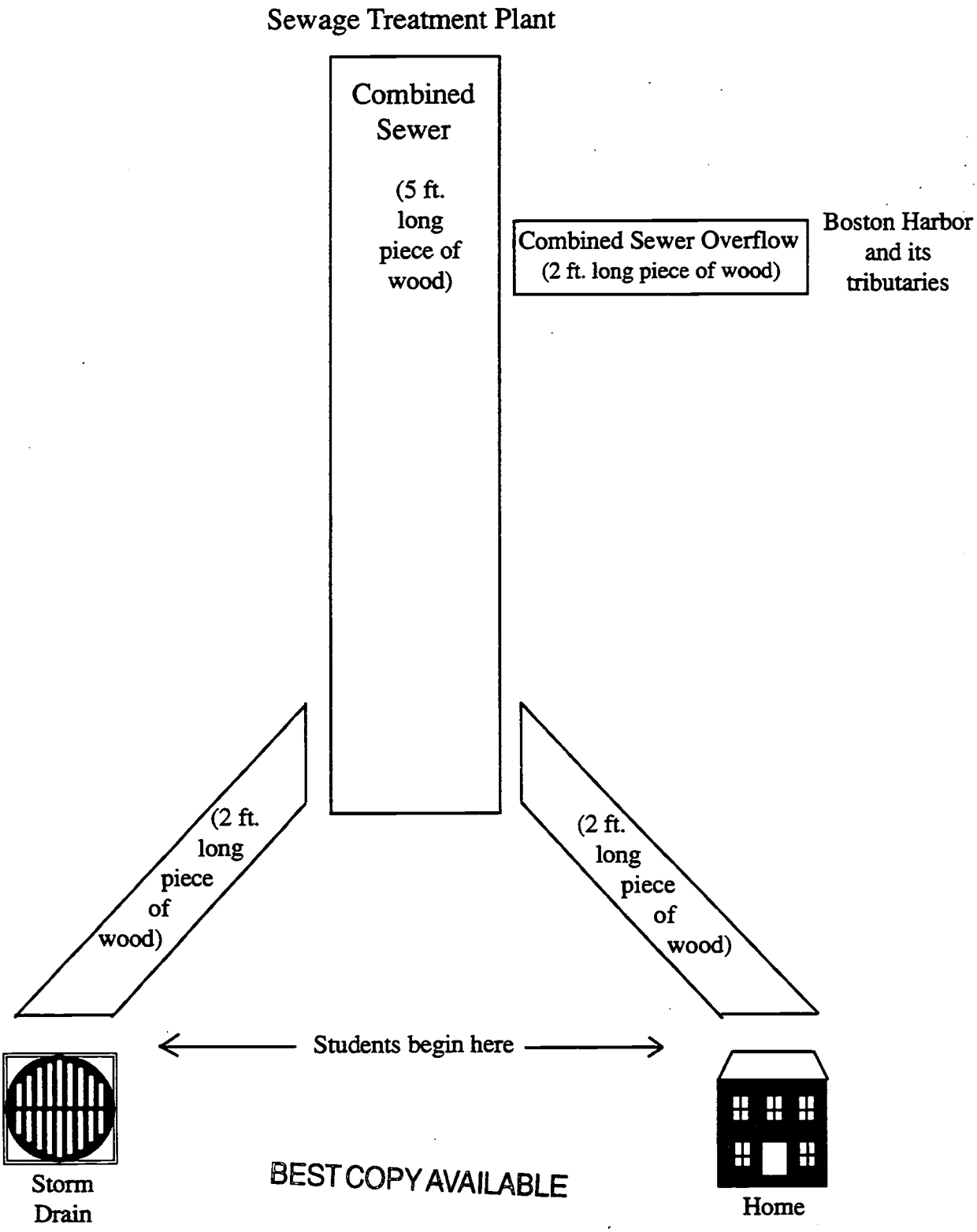
4. Ask the students: What happens to the wastewater that went down the OUTSIDE DRAINS or STORM DRAINS? Does that also go to the treatment plant? In most cases, no! This wastewater is discharged to a stream or brook in your community. Most communities have what is called SEPARATE SEWERS. (A separate sewer system has separate sets of pipes for the inside and outside wastewater.)

5. What is a COMBINED SEWER SYSTEM? (A combined sewer system is one in which the wastewater from both inside and outside are combined in the same set of pipes.) What kind of system do we have in our community? (If you live in Boston, Cambridge, Chelsea or Somerville you live in a combined sewer community. The other cities and towns within the MWRA district have separate sewers.)

6. Review the lists on the board. The wastewater listed under INSIDE DRAINS goes to the treatment plant. The list under OUTSIDE DRAINS is discharged to a body of water in your community with out being treated. What happens when the lists are combined? Where does the wastewater from combined communities go? Most of the time it goes to the treatment plant before being discharged. But sometimes, especially during heavy rainfall, the combined sewers can't handle the added flow and the wastewater is discharged directly into Boston Harbor. Ten to twelve billion gallons of untreated wastewater or raw sewage, as it is sometimes called, is discharged into receiving waters yearly through combined sewer overflows.

7. Now it's time to demonstrate how these combined sewers are activated. Set up materials for demonstration as shown in figure. The large board represents the combined sewer, one of the smaller boards represents the sewer pipes from homes, etc., the second smaller board represents the sewer pipes from storm drains and the third smaller board represents the combined sewer overflow. (See diagram on next page)

Combined Sewer Overflow



8. Divide the class into two equal groups. Place a container with the styrofoam bits in it at the HOME spot and another at the STORM DRAIN spot. Have one group line up single file at the end of the 2 ft. board representing HOME. Have the other group line up single file at the end of the 2 ft. board representing STORM DRAIN. Have the first student in each line take a handful of styrofoam bits which represent the "waste" in wastewater. As each student moves up, becoming the first in line, have him/her take a handful of bits.

9. The teacher says the word "FLUSH" and signals the first student in line at the HOME spot to walk down the small board as the wastewater from a toilet being flushed would leave the house via a drain, then continue down the longer board to the end, as wastewater would travel to the treatment plant. The student should stand at the end, count to 3, giving time for treatment and then throw the styrofoam bits into a container at the end to demonstrate the discharge of wastewater into Boston Harbor. Now the student returns to the back of the line he/she started in.

10. The teacher says the word "SHOWER" and signals the first student standing at the HOME spot to walk down the boards as the previous student had done, representing the wastewater from the shower leaving the house traveling through pipes to the treatment plant. Remind the student to wait 3 seconds at the end to allow for proper treatment before discharging the wastewater into Boston Harbor.

11. The teacher now says the word "GARBAGE DISPOSAL" and signals the student at the HOME spot to repeat the steps the two previous students had just completed.

12. You have just demonstrated how wastewater from a home travels to the treatment plant and is discharged into Boston Harbor. It seems to run very smoothly, the wastewater receives treatment before being discharged into the harbor. But, wait! It's raining and this is a COMBINED SEWER.

13. Now the teacher says "RAIN" and signals the first student in line at the STORM DRAIN to walk along the pipes to the treatment plant

as the students before had done. Tell the students that the rain is coming down hard. Have the students in line at the STORM DRAIN spot follow one another down the pipe. Have each student in line at the STORM DRAIN spot count to 3 silently after the previous student starts to travel. Then continue as the previous student had done, allowing 3 seconds at the end of the long board for proper treatment at the plant. The student then returns to the back of the line.

14. The students in the STORM DRAIN line are continuing down the pipes every 3 seconds representing the rain and all the waste that is washed down the sewer with it.

15. The teacher now gives the signal "FLUSH" and the first student in the HOME spot walks down the pipe. The students from the STORM DRAIN are continuing every 3 seconds. The teacher now says the word "SHOWER" signaling the first student at the HOME spot to start down the boards. The teacher says the word "GARBAGE DISPOSAL" signaling the first student at the HOME spot to start down the boards. The STORM DRAIN line is continuing every 3 seconds.

16. The pipes are starting to get backed up. The students should be bumping into one another about now. As the "COMBINED SEWER" gets backed up, instead of having the students back up into their respective HOME or STORM DRAIN line, have some of the students move off to the 2 ft. board on the right which represents the CSO. This demonstrates how untreated wastewater is discharged to receiving waters.

Discussion

Can anything be done about CSOs? (Possible answers: build separate sewers, build bigger treatment plants, build storage for excess wastewater, or build miniature treatment plants at each overflow.)

What would you do?

What is the MWRA doing? (See background information on page 3-6)

Background

When people think about the pollution of Boston Harbor, the first vision that comes to mind is the Deer Island and Nut Island treatment plants. Together, the two plants discharge 500 million gallons a day of processed wastewater into the harbor.

But there is another source of pollution to the harbor that is as detrimental as those two discharges. It is pollution from **Combined Sewer Overflows (CSOs).**

There are 84 **CSOs** located within the sewer system, many discharging sewage as often as 65 times a year, or an estimated 10.4 billion gallons of sewage.

By comparison, the Deer and Nut Island plants discharge roughly 180 billion gallons of treated wastewater per year.

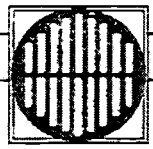
Combined sewer systems carry both rainwater and sanitary sewage from households and businesses in one pipe. During rainstorms, this combination often overloads local sewers and the MWRA interceptor system. As a result, the flows back up and overflow through discharge points known as **CSOs.**

Boston, Cambridge, Somerville and Chelsea constructed **combined sewers** in the late 1800s and early 1900s. At the time, there were no treatment plants in place. Prior to the construction of the **combined sewer system,** rainwater and sanitary sewage was simply collected in the streets.

A system that removed the sewage and rainwater from the streets and discharged it into Boston Harbor and its tributaries was certainly an improvement over existing conditions. It was considered an accepted practice, because the volume and nature of the combined sewage was different than today's. Sewage, and sanitary standards were loose or non-existent.

Today, in addition to the huge population increase, there are over 5000 industries within the MWRA sewer system which discharge their waste products into the system. Together, these factors have dramatically altered the volume and content of wastewater.

Although Boston, Cambridge, Somerville and Chelsea are the only communities with **CSOs,** they are not the sole source of the problem. Some communities



have **combined sewers** which discharge into the MWRA system, but have no overflow pipes in their system.

Still others contribute to the **CSO** problem by not maintaining their sewer lines properly.

One of the major sources of excess flow into the **combined sewer system** is clean water. Through cracks and breaks in the sewer system, rainwater, groundwater and water from rivers and streams can enter the sewer system. Not only is treating clean water an unnecessary expense for the MWRA sewer communities, it also places an added burden on the aging sewer system and sewage treatment plants.

In addition, it threatens the new plant's ability to provide for future growth of the region.

To combat this problem, the MWRA currently inspects its own 270 miles of sewer lines for breaks and cracks and will help cities and towns inspect their sewer pipes and advise them on proper maintenance and repair.

Most **CSO** discharges receive little or no treatment. These discharges release anything contained in the sewage flow. They can cause bacterial contamination, which violates health standards, oxygen depletion, which threatens the health of marine life and increase the toxicity of our local waters.

Put more simply, these discharges result in the closing of area beaches and shellfish beds and soil the natural beauty of our waterways with unpleasant floating matter.

The MWRA has already begun several projects that will increase the operating efficiency of the Deer Island treatment plant so that overflows will be less frequent.

Improvements to the headworks, which screen wastewater before it receives primary treatment at Deer Island, should reduce discharges to just over 5 billion gallons per year, a 50 percent drop from current levels.

The MWRA has also built 5 **CSO** screening and chlorination facilities, called satellite treatment plants, with a sixth currently under construction. The addition of these facilities will help reduce the impact **CSOs** have on the harbor.

Combined Sewer Overflow

On a larger, more comprehensive scale, the MWRA is studying a **CSO** control program with an estimated price of between $650 million and $1.2 billion.

There are three areas dramatically impacted by **CSO** discharges - the lower Charles River, the Inner Harbor and Dorchester Bay.

In these areas, large tunnels will be constructed some 350 feet under the earth. Specially constructed shafts will be constructed to redirect sewage into these deep tunnels and away from overflow pipes. Sewage collected in the tunnels will be pumped to Deer Island treatment plant after peak flows have subsided, instead of being released into the harbor as overflow pollution.

In the three remaining areas - the Alewife-Mystic River, the Upper Charles River and the Neponset Estuary - where discharges are less frequent, other technologies will be applied. The proposed solutions are: near surface storage, in-system storage and limited sewer separation.

Near surface storage would use similar tunnels to store limited amounts of overflow until it could be pumped back into the system.

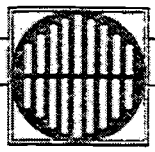
In-system storage would alter existing sewers to maximize the amount of sewage local pipes can hold before overflow becomes necessary.

Sewer separation would be used in specific, limited areas to redirect sewage away from **CSOs** and toward treatment plants.

When the MWRA's CSO control program and other programs from regulatory agencies like the state Department of Environmental Protection and the federal Environmental Protection Agency are in place, we can expect to see full results of Boston Harbor's rejuvenation.

(This article, written by Paul F. Levy, Executive Director of the Massachusetts Water Resources Authority, appeared in the ***Boston Business Journal***, January 15, 1990.)

Lesson 4(a)



Boston's Wastewater History

Lesson 4 consists of two independent activities. Lesson 4(a) compares the wastewater histories of Boston and London. Lesson 4(b) on page 4-13 compares Boston's wastewater issues of today with those of a century ago.

About this section...

The study of the wastewater treatment process and the Boston Harbor Project is often thought of as strictly science related. However, this topic expands into many different areas including history, English, government studies, current affairs and health.

These next activities help students realize that these issues affect their lives every day and will affect the lives of future generations just as they have affected their forefathers .

These activities do not attempt to give "right" and "wrong" answers. Their purpose is to stimulate students to think about important issues.

Lesson 4(a)

Purpose:

To point out that sewerage systems and wastewater treatment are an important element of the infrastructure of developed areas around the world.

Lesson in brief

Students read about Boston's sewerage system and London's system and note the differences and similarities.

Key words

Cholera Infiltration Inflow I/I Midden

Materials

Student Packet 1 - Taken from: **"Restoration of Sewerage Systems (The Assessment of the Problem in the UK")**.
Student Packet 2 - **"A Look Back at Boston's Sewerage System"** & **"How We Operate One of The Oldest Sewerage Systems in America"**.
Current newspapers and magazines.

Time required

Homework assignment plus one or two class periods for activity.

Boston's Wastewater History

Preparation

Call Meg Tabacsko at (617) 242-7310 to obtain student copies of "**How We Operate One of The Oldest Sewer Systems in America.**"

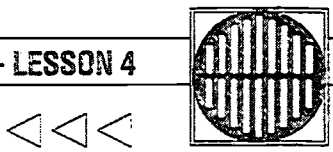
Procedure

1. Divide the class into two equal groups. Hand out copies of Student Packet 1 (information on London's system) to one group and pass out Student Packet 2 (information on Boston's system) to the other.

2. Instruct students to read their respective packets and be prepared for someone from each group to give a brief oral report the next day on their assignment.

3. After each group has made its presentation, initiate a discussion.
   What are the similarities?
   What are the differences?
   Should Boston have learned from London?
   What changes/improvements would you suggest?

4. This activity can be made into a long term project by having students research the sewerage system and treatment technologies in place in different cities throughout the country and the world.



Student Packet 1 - London

Directions: Read the two excerpts listed below, the first one written in 1878 about the London Sewer System and the second one written in 1990 about the Boston Sewer System. Continue reading about the London Sewer System and be prepared to discuss issues tomorrow with your classmates who are reading about the Boston Sewer System.

Excerpt 1:

The Boston Transcript, January 7, 1878

SEWAGE IN THE HARBOR

The failure of the new sewerage system of London (on which our projected three-million-dollar improvements is modelled) to get rid of the sewage...

Not even the views of engineering authorities if they are prepossessed or committed in favor of the scheme, should be permitted to go on and make the harbor, which is our great local source of health and pleasure, and our main reliance for the business future of the city, the constant stink and cesspool, with growing shoals in new places, that the Thames is becoming under this system according to unimpeached testimony.

... the sewage let out on each tide reaches the neighborhood of the lower light, and would, "on its return with the flood tide, be so diffused as not to be perceptible," Engineer Clark thinks. It is precisely on this lattle (sic) point that the actual experience of the London sewage has disappointed the engineers' theory of "diffusing." It does not "diffuse" "worth a cent."

Excerpt 2:

"How We Operate One of The Oldest Sewer Systems in America". Massachusetts Water Resources Authority, 1990.

...Digested sludge has been discharged into Boston Harbor on the outgoing tide since the Deer and Nut Island plants opened. The theory was that the force of the tide would carry the sludge away and disperse it. One look at the harbor today disproves that theory; it is estimated that at least 20 percent of the sludge returns on the next tide...

Taken From:

"Restoration of Sewerage System"
Proceedings of an international conference organized by the Institute of Civil Engineers, held in London on June 22 - 24 1981. Thomas Telford Ltd. c 1982.
"The Assessment of the Problem in the UK", E.C. REED, OBE, DFC, FIMunE, FIWES, FBIM, MIWPC, Thames Water Authority.

The author reviews the growth of sewers from the early nineteenth century and makes assessments of what is now in use in the United Kingdom. He goes on to describe the problem now facing the water industry and what has been achieved in finding the solution. He stresses that it is essential to exploit our greatest asset - the hole in the ground.

"As one who long in populous city pent, where houses thick and sewers annoy the air." MILTON (1608-74)

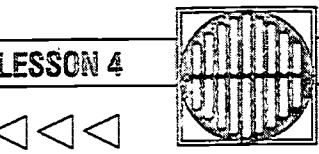
HISTORICAL BACKGROUND

1. The United Kingdom, with a figure of 94% connected, enjoys the benefit of the highest proportion of households on main drainage in the world. The beginnings of this drainage system was the direct result of the Industrial Revolution which caused a large proportion of the population to shift from the countryside into towns and cities.

2. In the early part of the eighteenth century town drainage consisted of open ditches which flowed into the existing streams or rivers. The enormous increase in the number of houses that were built and in the amount of paved area that was laid created a vast increase in the runoff of surface water. This in turn caused the already full drainage ditches to overflow exacerbating a health hazard that was to become a curse of the Industrial Revolution.

3. The water supply, although preceding sewerage, was rudimentary in its distribution and stretched available resources to the limit to the extent that pumped water was only available two or three times a week.

4. The habits of the population, the use of midden heaps and privys adjacent to water supplies, was largely responsible for the spread of water borne diseases such as cholera although this fact was of course not known at this time. Dr. John Snow, whose name is now immortalized by a London public house in Broad Street, first applied what is now known as epidemiology and correlated the cases of a violent cholera outbreak with the use of a particular water pump. In ten days in 1894 500 people died in an area bounded by three streets and these people all drew their water from one well.



5. As a result of Snow's deductions the pump was closed and eventually it was discovered that sewage was seeping into the well that supplied the pump. It was not until 30 years later that Robert Cork isolated the virus and proved Snow's theories.

6. The following notice which appeared in The Times newspaper in 1849 perhaps paints the backcloth to this history of sewerage for it is the incredible poverty and suffering of the working classes that demanded recognition and swifter change.

"A Sanitary Remonstrance"

We print the following remonstrance just as it has reached us, and trust its publication will assist the unfortunate remonstrant.

The Editur of the Times Paper

Sur,

May we beg and beseach your protekshion and power. We are Sur, as it may be, livin in a Wilderniss, so far as the rest of London knows anything of us, or as the rich and great people care about. We live in muck and filthe. We aint got no privis, no dust bins, no drains, no watersplies, and no drain or suor in the hole place. The Suer Company, in Greek St, Soho Square, all great, rich and powerfool men, take no notice watsomedever, of our cumplaints. The Stenche of a Gulley-hole is disgustin. We all of us suffur, and numbers are ill, and if the Colera comes Lord help us.

Some gentlemans come yesterday, and we thought thay was comishoners from the Suer Company, but they was complaining of the noosance and stenche our lanes and corts was to them in New Oxforde Street. They was much surprised to see the seller in No 12, Carrier St, in our lane, where a child was dyin from fever, and would not beleave that sixty persons sleep in it every night. This here seller you couldent swing a cat in, and the rent is five shilling a week; but there are greate many sich deare sellers. Sur, we hope you will let us have our cumplaints put into your hinfluenshall paper, and make these landlords of our houses and these comishoners (the friends we spore of landlords) make our houses decent for Christians to live in.

Preaye Sir come and see us, for we are living like piggs, and it aint faire we should be so ill treated.

We are your respeakfull servents in Church Lane, Carrier St. and other courts.

Teusday, July 3, 1849

7. At this time sewers are already in existence, but have been built to relieve flooding and up to the year 1815 it was illegal to drain sewage into them. However, sanitation problems became so great that the Authorities accepted the practice, but it was 1847 before the law was changed and it then became compulsory to drain houses into the sewers.

8. We probably owe the birth of our sewerage system in the UK to a major cholera epidemic in 1831 which caused a Royal Commission to be set up the following year. Edwin Chadwick was one of the District Commissioners appointed and it was he who produced the famous report on the sanitary condition of the labouring population in 1842. The data collected over five years makes sobering reading but it is the recommendations that are of interest to us today and they include the establishment of drainage systems and the concept of soundly designed sewers with self- cleansing velocities.

9. Development followed rapidly and some men were inspired to innovate. Such a man was Joseph Bazalgette for it was he who was faced with solving the problem of "The Great Stink" in 1858. Sewers, which had been laid to convey storm water ran directly into the river so that the waste of the Metropolis converted the Thames into an open sewer. Bazalgette constructed interceptor sewers on both sides of the river picking up all of the main outfalls and conveyed the flows downstream to Barking and Crossness. In a 15 year period from 1859 some 100 miles of large trunk sewers still in use today, were constructed.

10. We are indeed fortunate that the Victorians did everything on a grand scale for we are still living off the fat that the early enthusiastic drainage engineers provided. It is, however, unfortunate that we have not treated these buried assets with the respect that they deserve for there is little doubt that some of our sewers are in a serious structural condition. But how many and how serious - that is the question.

Assessing the Problem

1. In 1975 the recently formed National Water Council jointly with the DoE set up eight standing technical committees to cover all aspects of the water cycle. One of these, Sewers and Water Mains, gave an opportunity for known engineering experience to be applied to a national problem.

2. Four major difficulties became immediately obvious:

lack of knowledge, lack of records,

known aging, no use of failure records.

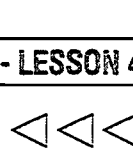
3. The first step was to publicise the problem and the National Assessment was published. This has since proved to be the forerunner of a whole host of articles and papers, many of which have relied on that original document for their data. That data was not easy to obtain and it was with some difficulty that it was established that the total length of public sewers in the UK was in the order of 234,000 kms.

4. If sewers are considered to fall into two size categories, man-entry and non man-entry, only 5% of the system in the UK are of man-entry size. The remaining 95% consist of 25% which are between 300mm and 1m. and 70% 300mm diameter or less. This assumes that 1 m. diameter is of man-entry size, an assumption which is debatable.

5. We know that some of our sewers are well over 100 years old but we know little of the age distribution or the growth rate for the system. A number of theories have been propounded based, for example, on population shift and house building and both of these give some guidance.

6. The value of our underground sewerage assets updated from Q1 1975 to Q1 1981 prices has been estimated as L42000 million and although the accuracy of this figure may be suspect, it is as was stated in the forward of the National Assessment, the best estimate that can be derived from the present available data.

7. The exactness of the figure is not important, but the following message from the forward of the National Assessment is still valid today.



"The reader will see the two messages come out of the paper loud and clear; the first is that the quality of information available about these buried assets varies tremendously across the country, the second is that whichever way it is looked at, current expenditure on sewer and main maintenance does not appear to be keeping pace with the inevitable deterioration taking place."

8. There is no doubt that the problems that we are currently faced with stem from lack of proper maintenance over several decades. It appears that too little money has been reinvested in a valuable asset although it must be appreciated that if a reasonably accurate depreciation rate is not established it is impossible to calculate what this annual expenditure should be.

9. Apart from the lack of basic record data already mentioned we do not know the structural life or the rate of deterioration, parameters which are absolutely crucial for the establishment of a strategy to overcome a backlog of neglect. This strategy unfortunately must be developed in a climate of economic decline when our available resources are being stretched almost to the limit. There is therefore little room for manoeuvre and we must make every penny count.

What Constitutes the Problems

1. Our sewerage system spans some 150 years but age is not necessarily the only criterion by which to judge the condition. There are numerous factors which are contributory to the present poor state of the reticulation. These include depth, geology, height of the water table, pipe specification, influent, quality of workmanship, adjacent services and traffic loading.

2. These factors sometimes individually, although more often in combination, manifest themselves in a range of faults which include cracks, fractures, collapses, blockages, deformation, displaced joints, erosion, corrosion, infiltration, exfiltration, tree root intrusion, rat infestation, and open joints.

3. It is not possible in the space and time available, or indeed with our present knowledge, to try to fully associate these faults either with each other or the factors that contribute to them. Nevertheless, some explanation is essential because it provides some of the background for the papers which follow.

The Way Ahead

1. Some progress has been made in the last 2 to 3 years in getting to grips with the problem but there is serious need to accelerate our efforts. Do the Bazalgettes of 1981 have any hope? Only if the problem is understood, assessed and grasped. First and foremost we must redress the balance of knowledge. Who was it who said that "A man who does not understand cannot participate - he can only interfere"?

2. The need for money is undoubtedly an impediment to progress. But are we making the best use of the money that is at present being spent on sewers? There is ample evidence of old fashioned and expensive methods still being pursued in many parts of the country today. The proposed cost of relaying should be tested against

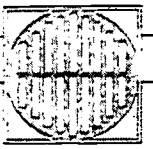
the cost of renovation - all new work should take account of the latest experience.

3. We have a decade for drinking water and sanitation. Why not a decade for our sewers? This could comprise a planned progression of survey, an identification of need for action, a follow up of renovation and, where necessary, renewal. This would, I feel sure, show up the expensive "fire brigade" activities which are the present norm. Information gleaned from this quest should then be used to rank our sewers in order of priority for attention or reinspection.

4. A positive effort is required to accelerate the development of renovation methods and this can only be achieved by collaboration amongst all interested parties. Experience has shown that in situ renovation methods undertaken on an experimental basis can be as much as 25% below renewal costs. It is reasonable to suppose that, as experience moves these methods out of the research and development class, cost will fall even more.

5. We should not need to be reminded that money is in very short supply; equally we must never lose sight of the need to preserve our valuable underground assets and not leave them to rot until they are beyond redemption.

6. There is an old maxim that what a layman can do for L100, a good engineer can do for far less. We now have a splendid chance for consultants, scientists, authority engineers and contractors to meet this challenge. Let us display our skills and prove our capabilities.



Student

Packet 2 - Boston

Directions: Read the two excerpts listed below, the first one written in 1878 about the London Sewer System and the second one written in 1990 about the Boston Sewer System. Continue reading about the Boston Sewer System, (this includes the brochure "How We Operate One of The Oldest Sewer Systems in America") and be prepared to discuss issues tomorrow with your classmates who are reading about the London Sewer System.

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A LOOK BACK AT BOSTON'S SEWERAGE SYSTEM,

Massachusetts Water Resources Authority, 1990

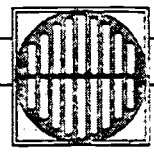
As the population of the City of Boston increased to almost 17,000 in the early 1700's, numerous waterborne epidemics accounted for the high death rate among the inhabitants. Eighteenth century technology consisted only of some open culverts and wooden pipes installed by property owners in order to drain standing water from their land and cellars to nearby tidal areas.

When the newly chartered City of Boston assumed ownership of this drainage system in 1833, sanitary waste disposal was permitted. The original Town of Boston had steep slopes with good tidal transport characteristics; later when many areas of the Back Bay were filled in, deposits and slow flow became a serious problem. In 1834, the connection of roof drains was allowed (creating the first combined sewers) in order to provide a greater flushing action following storms.

In the 19th century, more buildings were built on land filled with cellars below the water table. This greatly deteriorated the flow characteristics of the sewers since the pipes had to be extended through the fill at extremely low slopes. Tide gates became necessary to keep the incoming tides from flowing into sewers, thus permitting the sewers to discharge only at low tide when transport of the waste was very limited. As a result, the near shore waters of the Charles River and the Inner Harbor became grossly polluted, and due to the retention of sewage in the pipes during high tide, the problem of deposits worsened, which in turn caused gases to waft back through the poorly ventilated sewers and into buildings and homes.

In the late 1800s, the death rate had further increased and the stench of sewage overpowered all parts of the City. A commission was formed to investigate the problems and recommend solutions. Two physical systems were proposed which would drain into ocean locations where the tide was strong enough to sweep away the discharge sewage. (The North System would discharge near Deer Island and the South System would discharge near Moon Island.) Thus began, in 1885, the rudimentary form of our present day sewer system, which collected combined sewage pumped to screening devices and holding tanks via submerged tunnels. However, the capacity of this system was such that transport of storm flows was not feasible, so a system of upstream overflows was incorporated to provide relief following heavy rainfalls. Despite these overflows, sanitary conditions were greatly improved, with odors and complaints essentially eliminated in the areas served by this system.

The Metropolitan Sewerage District (MSD) was formed in 1889 and given the responsibility of managing the ever increasing sewer districts north and south of Boston, while the City of Boston managed the Boston Main Drainage System with its outlet at Moon Island. By 1895, new interceptors, pumping facilities and outfalls were completed to serve additional communities. When additional communities in the southern portion of the MSD were incorporated in 1904, flows were diverted to Nut Island, creating three physi-



cally independent systems for the collection, screening and disposal of sewage.

In 1919, the newly created Metropolitan District Commission (MDC) assumed the responsibilities of water and sewer along with other services. The MDC undertook numerous comprehensive studies in the 1930's of the pollution problems in Boston Harbor, which resulted in many recommendations, with the conclusion to construct primary treatment facilities at all three discharge locations.

Nut Island was completed in 1952 and Deer Island was completed in 1968. All flows from Moon Island were diverted to Deer Island instead of a third treatment facility that would have to be constructed. These two facilities provided the same capacities and treatment concepts that are still in existence today. These include grit and screening removal, primary sedimentation, chlorination, sludge digestion (anaerobic) and discharge to the harbor on the outgoing tide.

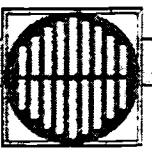
In the early 1970's, it was determined that some 15 to 20% of the sludge discharged on the outgoing tides returned to near shore areas of the harbor on the next incoming tide. Despite investigations and recommendations for alternate means of sludge disposal, this practice still exists today, together with the impact of combined sewer overflows. Boston Harbor has become badly polluted.

In 1984 the City of Quincy filed a law suit in the state court against the MDC, brought about by the frequency of human waste and grease clumps deposited on Quincy's beaches. The outcome was the creation of the Massachusetts Water Resources Authority (MWRA), a new agency with fiscal autonomy to handle the cleanup of Boston Harbor. The MWRA took over responsibility for all water supply and wastewater treatment facilities from the MDC on July 1, 1985.

Sewerage systems are designed to be out of sight and as the saying goes, "Out of sight, out of mind. "We can't ignore the problem any longer. Something has to be done about the present condition of Boston Harbor and we are on ourway.It won't happen overnight and it won't be cheap. The Boston Harbor Project will take until the year 2000 to complete and will cost in excess of $6 billion.

*Continue reading **How We Operate One of The Oldest Sewer Systems in America** to find out what's happening today.*

Lesson 4 (b)



Lesson 4(b)

Purpose:

To point out that Boston has faced serious wastewater issues at other times in its history.

Lesson in brief

Students read newspaper articles from the late 1800s and early 1900s as well as current articles, then compare yesterday versus today.

Materials

Enclosed newspaper articles.
Current newspapers and magazines.

Time required

Minimum of one class period.

Procedure

1. Read aloud the HEADLINES. Have the students try to guess when each article was written.

2. Hand out the old and current newspaper articles for the students to read (you may want to have different articles read aloud in class).

3. Initiate a discussion about people's attitudes. What seems to be the main concerns?
   Money? Health? Environment?
   Are the attitudes today similar to those of the late 1800s and the early 1900s?

4. Initiate a discussion about the similarities and differences. (A few suggestions for discussion are listed on the following page).

Options for discussion

Definitions

Ask for a definition of the word "**scheme**," "**project**," "**water closet**" and "**bathroom**."

scheme (skem) n. 1. A systematic plan of action. 2. An orderly combination of related parts or elements. 3. A plan, esp. a secret or devious one; plot. 4. A chart, diagram or outline of a system or object. 5. A visionary plan.

project (proj'ekt', - ikt) n. 1. A plan or proposal; scheme. 2. An undertaking requiring concerted effort. 3. A research undertaking.

water closet n. A room or booth containing a toilet and often a washbowl.

bathroom (bath'room', - room', bath' -) n. A room equipped with facilities for taking a bath or shower and usually also containing a sink and toilet.

Today when one thinks of the meaning for the word, **scheme**, "A plan, esp. a secret or devious one; plot," comes to mind.

In the modern newspaper articles, we refer to **The Boston Harbor Project**, **The Wellesley Sewer Relief Project**, etc. Old articles about the sewer system show that today's "project" was yesterday's "scheme."

Today, the term **water closet** is obsolete in newspaper articles (the term is still used for plumbing regulations). We refer to bathrooms and rest rooms. Did these modern terms even exist back in the late 1800s and early 1900s?

Are there other differences in terms of word meanings and usage?

Spelling

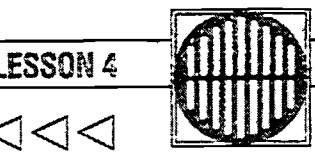
Notice the difference in spelling between older articles and present day.

Centre vs. Center

Why did the spelling change?

Refer to the London articles in Lesson 4(a). "**Centre**" is still used today.

Are there other words similar to **centre** and **center**?



5. Have the students read newspapers from their own city/town and the Boston papers and cut out any articles that mention MWRA, sewers, Boston Harbor, etc. Again talk about similarities and differences from 100 years ago.

6. Have the students write their own newspaper articles. Encourage them to interview parents, teachers, elected officials, MWRA employees, local Department of Public Works employees, etc.

7. Have the students participate in the MWRA Boston Harbor Essay Contest. For more details regarding this event, contact Meg Tabacsko at (617)242-7310.

NEWSPAPER HEADLINES:

A Disgrace to the City

"Heart of Boston Sewer System in Lamentable Condition...Immediate and extensive repairs necessary"

"Lack of funds and proper care causes of present state of affairs...Officials have done all they could with money at hand..."***Boston Herald***, July 27, 1896

Fatal Shore

"How Boston Harbor became such a mess, and what's being done to clean it up..."

Boston Phoenix, June 15, 1990

Grave Menace

"...Boston Sewer System in Dangerous State...Improvements Imperative..."
Boston Herald, July 30, 1896

Draining the Hub

"The Intercepting Sewerage System Complete...Early building of sewers in Boston and the progress to the present time - How the sewage is carried along and disposed of.."
Boston Herald, January 15, 1897

Fighting the Cellar Floods

"...After an exhaustive study of the notorious sewer nuisance, reports three plans for a remedy, will cost tremendous sum - great private expense..."
The Somerville Citizen, April 15, 1898

Officials Send Deer Isle Waste Out to Sea

"Officials will recommend that wastewater from the planned Deer Island treatment plant be discharged nearly 10 miles out to sea..." ***Boston Herald***, October 31, 1987

Student Handout

Directions: Read the following newspaper articles which were written about the sewer system in the late 1800s.

Improved Sewerage

To the Editors of the Boston Journal:

As the system of "improved sewerage" is about to be constructed it is becoming apparent to many practical men and civil engineers that there are prominent defects in the proposed system and that it cannot be executed without creating serious difficulties. There are several features of the system which are experimental and appear to be chimerical.

It is evident that there has been a reaction, and that not only a growing mistrust and doubt exists in the minds of many regarding the efficiency of the scheme, but now after reflection the suspicion arises that the "improved sewage" of such great magnitude and cost was hastily adopted and forced through the City Council by popular clamor and the efforts of a few enthusiasts.

No costly experiments or mammoth engineering feats should be tried at any time, much less in these times of depression and distress. In this article it is propose to briefly consider a few of the difficulties and objectionable features of the scheme. Some of them have already been discussed, while others do not seem to have been thought of. The subject of lowering the ground water has recently been brought up by architects and others, and more particularly with reference to the preservation of the foundations of buildings upon the Back Bay territory. It is a serious matter, affecting not only that part of the city, but many acres of mercantile building upon made land in the older parts of the city bordering upon the harbor. These buildings have pile foundations, and most of them cellars protected from flowage by tide water by expensive watertight coffer dams or boxing.

This "Improved Sewerage" scheme proposes to lower the ground water several feet, and the assumption is that the whole city is to practically boxed in some way not yet shown, or, perhaps, not much thought of, so as to exclude the tide water. No mention is made of this fact, but it is evident it must be done to carry out the idea of lowering the ground water. This system of drainage as proposed is not feasible, unless the tide water is excluded, and to do this will require a large expenditure. When that is done what are the results? They are the inevitable rotting away of the pile foundations of many hundreds of buildings, the rotting away of the expensive boxing around blocks of buildings or exposure of the cellars and goods therein to flooding by every heavy rain fall occuring at high water. Also the rotting away of all the wooden sewers of many miles in length belonging to the city and the consequent reconstruction of them at greatly enhanced cost of materials.

Another idea presents itself and that is, if the tide water is not effectively prevented from flowing into the new and old sewers through innumerable sea walls, old drains, cob wharves, foundations and permeable ground, pumps of enormous capacity and cost must be provided at the pumping station in Dorchester, not only to remove the ordinary sewage and small rainfall calculated upon, but in addition, the great quantity of sea water leaking into sewers at every tide.

The question has recently been much discussed concerning the prospective formation of mud banks in the harbor and offensive deposits of sewage matter upon the beaches of the island, after the "Improved Sewerage" scheme is put into operation.

In the Commissioners' report it is stated that the inclination of all the sewers is to be sufficient to give a minimum velocity of about two miles per hour, and thus prevent any sediment in them. Now if this sewage should have its velocity reduced, it is evident that sediment will then be precipated.

If the sewage could be retained for a short time in properly constructed settling basins, the sediment would be precipitated into the basins, and afterwards might be remove and possibly made use of, and the sewage, thus relived of its heavier matter, then be allowed to pass off into the harbor at proper state of tide without forming an appreciable deposit or becoming offensive.

Excerpt from the ***Boston Journal****, January 24, 1878*

A Bombshell

A New One Fired by the Only H.H. Faxon. This Time He Is out Against the Sewer. He Says It Is A Scheme That Will Breed Salary Grabbers.

Henry Faxon, the only and irressible(sic), is on the warpath again threatening destruction to everyone in general and the sewer system in particular. Several years ago Henry offered to build a sewer at his own expense. This sewer was to drain the centre of the city, but the selectmen refused to allow him to dig up the streets and ever since he has been jealous(sic) of the other sewer schemes.

Henry has not been seen much for the last two weeks. He excused himself on a plea of sickness, but now is evident that he has been employing his time in preparing one of his famous literary concoctions which are known to the world as "bombshells". The present manifesto makes interesting reading for anybody who is affeted by it.

It reads as follows:

In view of the fact that it would be the height of folly for one who pays an assessed tax on $450,000 to oppose any enterprise that would advance the health, morals, or business interests of the city, I invite your attention to some reasons against the construction of a sewer in Quincy at the present time.

1. Statistics show that the health of our people is excellent.
2. I believe that the project can be delayed 5 years without endangering the physical welfare of the community.
3. For several years only a small number would connect their premises with the sewer.
4. Digging up the highways would leave them in a deplorable condition to be prepared at great expense.
5. The burdens of the already overtaxed property holder would be increased.
6. The debt of the city would be augmented and we would not receive corresponding benefits.
7.. The immense debt and interest account consequent upon such and undertaking would deter those who desire to make Quincy their permanent abode.
8. When cheap tenement houses are connected with the sewer, the water closets will be receptacles of ashes, swill and other refuse.
9. The consumption of water will increase 1/3 in winter, as tenants will let water run all the time to prevent the pipes from freezing.
10. The scheme will necessitate a commission of political salary grabbers who thrive at the expense of honest citizens.
11. The city will be petitioned annually to construct additional mains in remote localities, where thousands of dollars will have to be expended with only perplexities as a return upon investment.
12. Quincy covers so large an area of territory that the outlay for mains will be much greater than other municipalities.

THE PRINCIPAL BENEFITS OF A SEWERAGE SYSTEM :

1. Will be derived by those speculators who buy clay bottom lands and lay out the same for house lots.
2. Will serve to enrich plumbers who are an expensive nuisance to any community.

CONSPICOUS (sic) NONSENSE

To advocate building the sewer at the present time because material is cheap and money can be borrowed at a low rate of interest.

To mortgage individual property of the city for long terms upon the plea that the future generations will pay the debt.

Except from the ***Quincy Daily Ledger****, Feb. 12, 1890*

Boston's Wastewater History

THE SEWAGE IN BOSTON; A VALUABLE SCHEME FOR ITS UTILIZATION
By Dr. E. H. DERBY.

The Moon Island Plan Criticised
-How Much Expense May Be Saved
-Dr. Derby's Report to the American Statistical Association
-Discussion by Drs. Folsom and Jarvis, and Mr. Otis Clapp.

At the meeting of the American Statistical Association in the Historic-Genealogical Society's rooms yesterday afternoon Mr. J. Wingate Thornton presided. The committee to consider ways and means to utiliize the sewage of Boston presented an interesting report, which was read by Dr. E. Hasket Derby. After noting the great increase in the water supply of the city within the last few years and the new requirements for drainage which this brings, Dr. Derby presented a statement showing that the deposits in Boston Harbor have been constantly increasing. For a long time it was the theory that our channels could be kept clear by the scouring process and that the refuse of the city would be born to sea by the ebb tide. But of late years accumulation of filth have have made their appearances on the border of our channels, and some of these channels have disappeared. ...In many cases this material has risen above the outlet of the drains of Boston, and deleterious gases bubble up from them, affecting the health of our people. The land, which can be reached at little expense, and which is made a real source of value. Now in Boston at least 125,000 tons of refuse flows into Boston Harbor and is nothing but a source of pestilence and injury. But little of the deposit reaches the ocean, and judging from past encroachments, within 50 years every channel will be filled and port destroyed, or at least six million of dollars must be expended to remove the deposit. Experiments with floats, as recorded in the report of the Sewerage Commission, go to disprove the old theory that thereturning flood tide must act as a scourer to the ships channel. Floats launched at Castle Island, in the main channel, at high water, met the flood-tide near the Graves and many of them were carried back by it and deposited on the flats by Apple Island. From these experiments we may safely infer that the sewage of the city, delivered as the Commissioners propose, during the first two hours and a half after high tide, or, on the average, one hour and a quarter later than the floats launched by them, must meet the flood-tide between Castle Island and the Graves, and be carried back and deposited on the shoals around or above the city. But the Commission plan, which might possibly work at London or Chicago, under different circumstances, suggests important questions. May not this sewage be utilized, as it now is near many of the great cities of Europe,...

Excerpt from the ***Boston Transcript****, July 26, 1877.*

The headline reads...

"BOSTON'S MAMMOTH NEW SEWER EXPLORED BY THE SUNDAY POST YOUNG WOMAN 200 FT. UNDER GROUND, CLAD IN OILSKINS SHE VIEWS THE MARVELS OF A COMPLETED SECTION OF THE GREAT UNDER-GROUND TUNNEL...FIRST WOMAN EVER TO ENTER THIS YAWNING CAVERN"

The story begins...

"In general, one doesn't associate anything agreeable with sewers. They're things that have to be when people are civilized and want to keep their houses and towns where they live clean and healthful, but at best they're a necessary evil, the least said about them the better. At least, that has always been my idea on the subject and I venture to say that is the way nine out of ten people feel about it."

"But I've discovered this week that a sewer is a highly interesting thing, after all, and that in order to give the city of Boston a proper system of sewage some of the most skillful technical men in the Commonwealth spend their time year after year, putting their heads together and originating new and marvellously (sic) interesting engineering projects."

Not a whole lot has changed in the thinking of most people when it comes to sewers and wastewater treatment. Most people don't think about the sewerage system around them, but once you do - it can be very interesting.

Excerpt from the ***Boston Sunday Post*** *on Sunday, August 12, 1900.*

Directions: **Continue reading articles about wastewater and the sewer system which have been written within the past few years. Consider the similarities and differences between the old and new articles. Be prepared to discuss your observations in class.**

Officials: Send Deer Isle Waste Out to Sea

by John Birtwell

WINTHROP - Officials will recommend that wastewater from the planned Deer Island treatment plant be discharged nearly 10 miles out to sea.

The Massachusetts Water Resources Authority, charged with the cleanup of Boston Harbor, yesterday recommended that a massive tunnel be drilled to carry millions of gallons of wastewater from the treatment plant. MWRA Director Paul Levy said the tunnel will cost $467 million and take five years to complete.

Residents north and south of Boston had worried about the outfall location, fearing the pipe would bring the discharge close to their shores.

But under the plan put forth by MWRA engineers, the 25-foot diameter pipe would carry nearly 500 million gallons a day almost seven miles from the nearest land point, agency officials said.

"If I were living in Nahant or Hull, or one of those communities I would be pretty pleased with this recommendation," Levy said.

He said if the recommendation is approved, the tunnel would stretch from 8.6 to 10.3 miles, terminating at a spot east of Winthrop.

He explained the treated water would be diffused through a series of pipes at the tunnel's end, in a "similar fashion as a lawn water hose with holes punched in it."

"We wanted to get out far enough so it is well beyond tidal currents," said Levy. "That way, you get better dispersal and you don't (worry) about it coming back in."

Levy expects considerable debate when the siting decision is presented to the MWRA board next week.

"This issue is as important as the other siting issues such as sludge, staging areas and treatment plants," he said. "We are making them now so the public can play a continuing role in helping us to reach this important decision."

The tunnel project is part of a multi-billion-dollar project to upgrade an replace the area's aged and overworked sewage treatment system.

He said boring of the tunnel through granite nearly 330 feet beneath the ocean floor would begin as soon as a down shaft is driven from the Deer Island plant site.

A final decision on the plan will be made next spring.

Boston Herald, October 31, 1987

High Hopes for the Harbor

PERSPECTIVE by Paul F. Levy

"Don't you think Boston Harbor was meant to be something of beauty, not ugliness?"

Sixth-grader Channa Yem of Revere expresses the boundless hope for the future of Boston Harbor that characterized nearly all of the entries in the Massachusetts Water Resources Authority's recent essay contest on the Boston Harbor cleanup.

At a time when too many people feel cynical and frustrated about the quality of the environment and government's ability to improve it, it's encouraging to look at the future of Boston Harbor through the eyes of our children. More than 300 young people from 21 schools in 18 towns answered our call to write essays on "Why It Is Important to Clean Up Boston Harbor."

"It took a lot of people to pollute Boston Harbor and it will take a lot of people to clean it up."

Jame Liljedahl, a fifth grader from Mattapoisett, points out the sheer enormity of the cleanup. Thousands of workers will labor on the project between now and the year 2000, when Boston will finally have a modern, efficient wastewater treatment plant. Work on the project is well under way at Boston's Deer Island, the site of the new plant.

- In August, work will begin on an underwater tunnel nearly 10 miles long that will take treated effluent from the new plant to the deep waters of Massachusetts Bay. That tunnel will be about the size of the Callahan Tunnel and roughly the distance from down town Boston to Rte. 128. This fall, we will start work on a second undersea tunnel from Quincy's Nut Island to Deer Island. That tunnel, five miles long, will take sewage from Boston's South Shore to the new plant for treatment..
- In December, construction will begin on the new wastewater treatment plant. The MWRA will complete a new primary treatment plant by 1995 and a new secondary treatment plant by the year 2000. For the first time in 23 years, Boston will be in compliance with federal environmental law.
- A plant that will convert sludge to fertilizer is under construction at the Fore River Staging Area (the former General Dynamics Shipyard) in Quincy and will begin operating in 1991, ending the discharge of 70 tons of sludge to the harbor each day. The pellets that will be produced from the sludge will be sold as fertilizer.
- "We have the capability to clean it up, so why aren't we? We're not too lazy to approach the job, are we?"

Melissa Morse, a middle school student from Reading, issues a welcome challenge, and one that we're meeting. Since the harbor cleanup began in 1988, we at the MWRA have had no time to be lazy. We have already stopped dumping scum (grease, plastics and other floatables) into the harbor, a step that means cleaner area beaches.

Military bunkers at Deer Island, built to be indestructible, have been demolished and removed, and millions of cubic yards of earth are being moved to make way for the construction of the new plant. Piers have been built at several sites to enable the movement of vehicles, equipment and construction workers to Deer Island.

A four-mile submarine power cable has been laid from South Boston to Deer Island to provide 20 megawatts of electricy - enough for a small city - to power construction equipment.

"The cost to clean Boston Harbor is great, but the cost not to clean it is even greater."

Jennifer Lane, an eighth grader from Narick, wrote a line that should accompany water and sewer bills sent to the MWRA rate payers. She continues:

"The communities that have polluted Boston Harbor must take responsibility for their actions and clean it up for themselves and future generations. Although cleaning Boston Harbor is a massive undertaking that will take years and cost billions it's a project that must be undertaken and completed."

Like many of the entrants who wrote about the Boston Harbor Project, Jennifer recognizes that all of us will reach into our pockets to pay the price of neglecting a precious natural resource, but that not undertaking the cleanup now will be more costly, both in environmental and monetary terms.

"People shouldn't be angry about paying more money because they will be saving wildlife and the water will be clean."

So advises Chris Martin, a fourth grader from Milton. Other young writers point out that we are all responsible for pollution, and note the embarrassment of having the nation's filthiest habor in the home of the Pilgrims and the U.S.S. Constitution, never mind the Celtics and the Red Sox.

"I think it's a shame that people think it's everybody else's fault, but not theirs," wrote Patrick Rowe, a sixth grader from Newton. "My father tells me about when he could swim in Boston Harbor. Well I guess times have changed."

These young people have heard tales of how Boston Harbor used to be, yet the future also weighs heavily on these young shoulders. "Future generations should not have to pick up after our mistakes," said eighth grader Kerri Boehm of Arlington. "I don't just want Boston Harbor cleaned up for my sake, but for generations to come," adds Tom Nardone, a seventh grader from Revere.

"The native people who inhabited our shores when the Pilgrims arrived believed that things in nature were a gift from the gods to be treated with respect...We should keep that tradition alive too; Boston Harbor deserves to be respected again."

Cynics who believe that we are unable to tackle and solve our environmental problems should heed the advice of Tim Sullivan, an eighth grader from Arlington. His passion is matched by many other young writers who believe that our once pristine harbor should once again be, in Channa Yem's words, "something of beauty." We agree with youn, Channa, and we're working on it.

Paul F. Levy is executive director of the Massachusetts Water Resources Authority.

Boston Business Journal, September 10, 1990

Boston to Get World's Longest Flush

BOSTON (AP) Toilets in the greater Boston area will have the longest flush in the world when an 8-mile-long, $400 million sewage tunnel under Boston Harbor is complete eight year from now, says a state consultant.

The Massachusetts Water Resources Authority plans to test the limits of current technology by boring through bedrock under the harbor over the greatest distance ever drilled from a single starting point, consultant John Gall told the Legislature's Committee on Natural Resources on Tuesday.

Gall, an associate at Camp, Dresser & McKee, explained that more detailed studies need to be done. But after spending $5 million on preliminary testing and design, the MWRA is leaning toward a plan to build the discharge tunnel eight miles east-northeast of Deer Island, where a new sewage treatment complex is to be sited.

"This would be the largest and longest in the United States and - I believe - in the world. We're stretching the limits," Gall said.

The Authority would sink a verticle shaft more than 400 feet down from the treatment plant into bedrock beneath the harbor. From that point, a tunnel 24 feet in diameter would rise gradually over a length of 45, 000 feet.

The next and last 6,600 feet of the tunnel would be connected to 80 "risers," shafts that would rise from the bedrock to the seabed. Each riser would carry treated waste effluent to the ocean surface, where it would mix with sea water.

At the point of discharge, according to Gall, the long-term average rate of dispersion would be 250 to 1 - that is, each gallon of wastewater would be dissolved in 249 gallons of seawater.

Gall said the entire system was being designed to operate by gravity, a design feature that would save more than $100 million estimated as the cost of a pumping station.

But in order to make the system work by gravity, the elevation of Deer Island in Winthrop will have to be raised by 20 feet. That could be accomplished by piling up the crushed rock taken out of the tunnel, he said.

Fall River Herald News, November 25, 1987

Humid Heat Plagues Boston

Pollution Closes Beaches

The Metropolitan District Commission (MDC) announced this week that they have closed Tenean and Malibu beaches in Dorchester, Wollaston in Quincy and Sandy Beach on Mystic Lake in Winchester. In addition to that, they are waiting for results from testing South Boston and and Orient Heights as well as Revere Beach. The MDC blames this on the heavy rains that we have been having which causes the sewers to overflow into the Harbor. This is the same old chestnut that they have been talking about for the last 50 years - the combined sewer overflows. The simple fact of the matter is, that we have always had rainy spells and we've always had pollution, not only in Boston Harbor, but places like Revere and Quincy, which are not part of Boston Harbor. This bad situation will continue even after we spend $7 billion to clean up Boston Harbor because the Massachusetts Water Resources Authority (MWRA) plans to construct combined sewer overflow tanks in 29 places in Boston Harbor stretching from the Neponset River to East Boston. The sewerage will be stored in these 150 ft. deep storage tanks on the harbor and then released with the outgoing tide when the rain stops. What a great idea to clean up Boston Harbor. In other words, if it doesn't rain, it will work. Now all we have to do is talk to God as George Burns does.

Meanwhile, the state Department of Public Works is telling the people of greater Boston that dumping 13.5 million cubic yards of polluted artery tunnel fill at Spectacle Island and filling in 105 acres of water around the island will improve the quality of Boston Harbor's water. This has to be the collossal "chutzpah" story of the century. It's no wonder that Julie Belaga, Regional Director of the Federal EPA, has branded Mayor Flynn as political grandstanding when he blames the White House for telling the state that they cannot dump all this polluted fill on Spectacle Island. No small wonder that the beaches are polluted and will continue to be polluted. Boston Harbor will never be swimmable despite denial by the MWRA to the opposite. The state waited too long to commence this project. They could have gotten federal money back in 1975 when it would have only cost $500 million to clean Boston Harbor, according to a Camp Dresser & McKee enviironmental and engineering study. But, Governor Dukakis and the state government asked for waivers on the cleanup of Boston Harbor for the past 15 years before they were ordered by the federal court to clean up the harbor.

Now, it might be too late. The already overtaxed home-owners and rentpayers in 53* cities and towns of greater Boston are now paying triple water and sewer charges because of this inefficiency and procrastination of the state government in seeking federal funds for the Boston Harbor cleanup. The same can be said of the fiscal chaos at the State House when the legislature refused to call back their members to cut the budget in 1988 which could have avoided the current fiscal debacle which caused income, sales and gasoline taxes to escalate sharply. This entire fiasco could have been avoided, including the Boston Harbor cleanup. People could have enjoyed swimming at the beaches in Dorchester, South Boston and Orient Heights. Revere Beach is a disgrace. It is so dirty that even at high tide, you need a bath when you come out of the water. Even Lynn and Swampscott beaches are polluted. The state officials call it a "red tide" which even contaminated our once famous clambeds for which tourists came thousands of miles to enjoy. We call it pollution in its worst stage and now we are paying for the dilly-dallying by our state government.

Greenfield Daily Record, Aug. 24, 1990

* Note: The article states "53 cities and towns." Actually, there are 43 cities and towns within the MWRA sewerage district.

PART 2

INTRODUCTION

Introduction

Currently in the Greater Boston area, a vast effort is underway to build new and larger facilities which will clean the wastewater which flows from the region's sewers into the harbor. "Cleaning" means removing solids from the water and disinfecting it. Solids are soluble and insoluble materials which have accumulated in the water as it was used in the homes, industries and businesses throughout the area.

While the cleaned water is allowed to flow to the bay, tons of removed solids--commonly called residuals--remain behind. Putting the residuals in suitable places is also the responsibility of wastewater treatment personnel.

The lessons in this section discuss residuals: what are they, where did they come from and what can be done with them once they are removed from wastewater. The intent is to allow students an opportunity to participate in the world-wide discussion of what is the best plan for handling residuals.

Technologies available are by no means completely evolved. The residuals industry continues to research and develop methods for improved residuals handling. As cleaning the environment becomes a high priority, opportunities are increasing for students to pursue careers in wastewater treatment and residuals handling.

Lesson 5

Residuals: Deciding What to do

Purpose :

To engage students in research, debate and presentation of ideas as to how sludge should be handled. To suggest that many decisions cannot be made easily, many factors have to be considered and not everyone will be pleased with the outcome.

Lesson in brief

Students are divided into groups and given information on a particular sludge use/disposal option for their fictitious sewerage district. They are to review the material and present arguments as to why their use/disposal option should be the one selected. A group of students acting as "the Board of Directors" must then decide the issue.

Key words and concepts

As the Boston area wastewater treatment system is rebuilt and enlarged, residuals(solids) which are removed from the wastewater must be properly handled. In the past, and until the new facilities are built, wastewater sludge has been allowed to flow into the harbor. By federal law, ocean dumping will no longer be allowed and students must find better solutions, as the issue belongs to them and to everyone who uses the wastewater system.

Compost	Landfill	Pelletizing	Sewage
Incineration	Leachate	Residuals	Sludge

Materials

Residuals Slide Show from the MWRA.
Information sheets.

Time required

A minimum of two class periods. This lesson could be extended into a long term research project which would require additional time both inside and outside the classroom.

Preparation

Contact Meg Tabacsko at (617) 242-7310 to obtain the Residual Slide Show. (Please allow a two week lead time).

Background information

Sludge has been dumped into the harbor with the outgoing tide for as long as there has been wastewater treatment in the Boston area. The MWRA is building a

new treatment plant, installing a new nine and one half mile outfall tunnel, working with municipalities to repair leaking sewer systems throughout the district and researching the most effective way to control the combined storm/ sanitary sewer overflows. None of these measures will have such a dramatic and immediate impact on Boston Harbor, however, as the end to dumping sludge in the ocean.

By December 31, 1991, the Massachusetts Water Resources Authority will cease to be one of the nation's last remaining ocean dumpers of sewage sludge and will become one of the nation's largest manufacturers of heat-dried sludge fertilizer, converting waste into a valuable resource.

The decision to convert MWRA sludge into fertilizer pellets was not quickly or easily made. The MWRA reviewed numerous sites in the MWRA service area and more than 20 different disposal technologies before a decision was made. The MWRA had to look into the future and project what its sludge disposal needs would be for years to come and then design and site disposal facilities to not only meet those needs, but to protect the land, water and air of the entire MWRA region.

Scientists from the MWRA and its consultants conducted extensive research on each potential site to determine the suitablility of the site for the use it was being considered.

Environmental impact studies had to be conducted, public meetings and hearings had to be held, and meetings with other governmental agencies were required. Economics and federal and state regulations had to be considered before the MWRA Board of Directors could vote on a final plan.

After much debate, the MWRA decided on what it believed to be the best available use/disposal methods for not only sludge, but for the other residuals as well.

Listed below are the disposal technologies which were ultimately chosen.

Grit and Screenings. The grit and screenings collected at the MWRA's five headworks facilities are presently removed by truck and disposed of in a Buffalo, New York landfill.

The MWRA has sited a 46 acre grit and screening landfill in Walpole, Massachusetts. Per court order, the landfill will begin receiving MWRA grit and screenings in 1994.

Scum. Prior to 1989, scum was mixed in digesters with sludge and discharged into the harbor. In December 1988, a scum fixation facility was completed on Deer Island that stopped the scum discharges. Today, the scum is mixed with

cement kiln dust and landfilled and used as landform on Deer Island. The liquid remainder of the scum is then treated by the digesters. In 1991, when sludge pelletizing begins, all of the scum will be added to the sludge.

Sludge. Beginning in December of 1991, sludge will no longer be dumped into the harbor with each outgoing tide. The sludge will instead be transported to the Fore River Staging Area (FRSA) in Quincy to be converted into heat-dried fertilizer pellets.

Under contract to the MWRA, the New England Fertilizer Company (NEFCo) will operate the facility and market of the pellets from 1991 to 1995. NEFCo will develop nationwide markets for the pellets. Based on the success of the program, the MWRA will implement a long term marketing strategy.

Things to Consider

What is wastewater sludge?

Sludge is a by-product of wastewater treatment. Liquid sludge usually contains 93 to 99.5 percent water as well as solids and dissolved substances that were present in the wastewater and that were added and cultured by wastewater treatment processes. Usually these wastewater solids are treated prior to ultimate use/disposal to improve the characteristics for these processes.

The characteristics of a sludge depend on both the initial wastewater composition and the subsequent wastewater and sludge treatment processes used. Different treatment processes generate radically different types and volumes of sludge. In general, the more thoroughly the wastewater is processed, the more sludge is generated. At an individual plant, the characteristics of the sludge produced can vary annually, seasonally or even daily because of variations in incoming wastewater composition and variations in the treatment processes. This variation is particularly pronounced in wastewater systems that receive a large proportion of industrial discharges.

The characteristics of a sludge affect its suitability for the various use/disposal options. Thus, when evaluating sludge use/disposal alternatives, a sewerage district should first determine the amount and characteristics of its sludge and the degree of variation in these characteristics.

Sludge Quantity

The amount of sludge that must be used or disposed of affects the economic and technical feasibility of the various use/disposal options. Two ways to look at

sludge quantity are the **volume** of the wet sludge, which takes into account both the water content and the solid content, and the **mass** of the dry sludge solids.

Sludge volume is expressed as liters (gallons) or cubic meters. Sludge mass usually expressed in terms of weight, in units of dry tons. Because the water content of sludge is large and highly variable, the mass of the dry sludge solids is often used to compare sludges with different proportions of water.

Key factors affecting sludge volume and mass are sources of the wastewater, wastewater treatment processes and sludge treatment processes.

Other Things to Consider

Sludge Constituents

The composition of a sludge can limit a sewerage district's choice of sludge use/disposal options or make certain options more appealing. The five constituents that are usually the most important in decision-making are:

- Organic content
- Nutrients
- Pathogens
- Metals
- Toxic organic chemicals

Procedure

1. Show the Residual Slide Show to give students a basic understanding of residuals; what are they, where did they come from and what can be done with them once they are removed from the wastewater. Encourage discussion among the students. (Although the slideshow will cover all residuals, grit and screenings, scum and sludge, this activity deals only with sludge.)

2. With your students, set up a fictitious sewer district. Listed below is an example of some factors you may want to consider. Remember, this is your district --- you decide what's important. You might list some of the "things to consider" listed in the background information on the board during this step.

	Example	Our District
Name	*Sewerville*	*MWRA*
# of Towns	*5*	*43*
# of Homes	*50,000*	*870,000*
# of Industries	*250*	*5,000*
Type of Treatment	*secondary*	*primary/secondary by 1999*
Average Flow (million gallons/day)	*30*	*500*
Sludge Production (dry tons/day)	*12*	*70/180 presently/ with improved treatment*
Type of District	*medium size community in agricultural region*	*large metropolitan area*
Things to Consider		*1000 acres of land would be needed to landfill 20 years worth of residuals* *Money needed to implement disposal option comes from rate payers*

3. Divide the class into 5 groups - one will be given information on composting, one on incineration, one on landfilling and one on pelletizing. The fifth group will act as the Board of Directors and receive all fact sheets.

4. Hand out the appropriate fact sheets so that each group can study the information and be ready to argue that their particular use/disposal method is the one that should be adopted by the Board of Directors.

The Board of Directors should be prepared to question each group as they argue for their particular use/disposal method.

The fact sheets for this lesson merely touch the surface of each use/disposal technology. It is highly recommended that additional research into the specific use/disposal method be required In addition to local libraries, which should have this information, you could also direct your students to:

MWRA Library
Charlestown Navy Yard
100 First Avenue
Boston, MA 02129
(617) 242-6000

EPA Library
JFK Federal Building
Boston, MA 02203
(617) 565-3300

Water Pollution Control
Federation (WPCF)
Public Education Department
601 Wythe Street
Alexandria, VA 22314-1994
(703) 684-2438

New England Interstate
Water Pollution Control Comm.
85 Merrimac Street
Boston, MA 02114
(617) 367-8522

5. Assign a day for the "public hearing" to take place. On that day, have the Board of Directors sit in the front of the classsroom. Have each group state its case as to why its use/disposal option is the best one available. It should be up to each group as to how they it present their case. (One group may choose to have each member of the group voice their support, while another may select an official spokesperson.)

6. After all arguments have been heard, the Board of Directors should convene and decide on one use/disposal option based on their individual understanding of each method as well as the testimony given.

7. The Board of Directors must address the groups and state which method they chose and why.

8. Members of the other groups should be encouraged to challenge the Board on their choice.

Incineration

What is sludge incineration?

Incineration is the combustion of organic material in the sludge. Some material in sludge will not burn, such as metals, sand, etc. This residue is called ash.

What purposes does incineration serve?

- It kills bacteria and viruses that are present in sludge.
- It destroys some of the chemical pollutants in the sludge.
- It greatly reduces the volume of waste that needs to be landfilled.
- It greatly reduces the transportation requirements associated with sludge management.
- It can produce electrical energy and steam for industrial processes.

What are the advantages of incineration?

Incineration is a proven technology and is widely used to dispose of municipal sewage sludge. According to a 1984 survey of sludge combustion facilities reported by the U.S. Environmental Protection Agency (EPA), over 200 sludge combustion facilities exist in the United States. Lynn, Massachusetts, and other cities like Detroit, Minneapolis-St. Paul and Los Angeles have operating sludge incinerators.

Air pollution from the incinerator smoke must be controlled. The technology needed to control the air emissions from sludge incinerators is similar to the technology that is used for other types of combustion facilities, such as power plants and waste-to-energy facilities.

Regulatory agencies have established procedures for ensuring that sludge incinerators receive a full environmental review before they are constructed. All incinerators must have a permit before operation can begin.

Incineration dramatically reduces the transportation impacts of sludge management. Many roads are crowded and the transportation of large amounts of material can add to congestion. Incineration dramatically reduces the volume and weight of sludge. For example, incinerating an amount of dewatered sludge that would fill as many as thirty two trucks would produce only three or four truckloads of ash.

Incineration creates a resource from a waste product. If designed to do so, the heat from a sludge incinerator can produce electricity and steam that can be sold to businesses, consumers or utilities. Energy than was once stored in the waste product can become a valuable resource.

What are the problems with incineration and how can they be solved?

Any method that is used to dispose of sludge, including incineration, will have some environmental impacts. However, there are ways to reduce or eliminate these potential problems. Care in the design and operation of a sludge incinerator are necessary to minimize environmental impacts. What follows is a list of some concerns about sludge incineration and descriptions of the best ways to respond to those concerns.

Problem: Air pollution.

Air emissions from incinerators are the most controversial issue for the public. The pollutants that people are concerned about fall roughly into three categories:

1. "Conventional" pollutants

Some of the emissions from a sludge incinerator would be similar to those created by facilities that burn fossil fuel. Carbon monoxide, nitrous oxide, sulfur oxides and small particles of liquid or solid materials all could be produced by a sludge incinerator, just as they are produced every time we start up a car. These materials can contribute to such problems as respiratory ailments, acid rain and smog. The vast majority of emissions fall under this "conventional" type category.

2. Organics

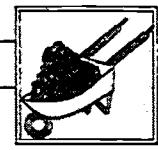
Certain materials such as pesticides, PCBs or other organic compounds may be present in sewage sludge. Some of these materials will be destroyed by the combustion process; others may be changed but not destroyed. These materials can have serious health and environmental impacts if they are not controlled.

3. Metals

Metals such as copper, cadmium, mercury and silver are present in sewage. These metals can come from many sources, both industrial and residential. Most of them will end up in the ash of the incinerator, but some of them, particularly mercury, may be left in the gases created by the combustion process. These metals can cause health problems if people are exposed to them in high concentrations.

Solution: Stop pollutants before they get to the treatment plant.

One of the best ways to reduce the amount of problem material in sludge (and



therefore in sludge incinerator emissions and ash) is by encouraging industries and households to significantly reduce the amount of material that is discharged into the system. To accomplish this, many industries are already required to pretreat their waste to reduce levels of problem pollutants.

Solution: Pollution control technology.

The quality of emissions from sludge incinerators is strictly regulated by federal and state environmental agencies. Special burning chambers, precise temperature control, sophisticated emission "scrubbers" and other methods to control emissions are required and regulated.

Problem: Leachate from ash could contaminate groundwater.

The ash produced by the combustion process contains all of the material that does not burn completely. This includes most of the heavy metals listed previously. When ash is buried in a landfill, the potential exists for these materials to leach if rainwater comes in contact with the buried ash. The leachate from this process could contaminate groundwater or surface water.

Solution: Build an environmentally safe landfill.

State agencies have strict regulations that must be followed when siting and operating any residual landfill. Such landfills must be designed so as not to impact drinking water supplies. They must be built with state-of-the-art technology including such features as double liners, leachate collection and treatment facilities to prevent groundwater contamination, and dust and odor controls.

Problem: Landfill space needed.

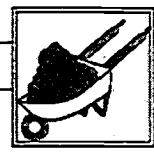
Although an ash landfill would take up much less area than a sludge landfill, it still needs a substantial amount of space. Obviously land that is used for a landfill cannot simultaneously be used for housing, open space or recreation.

Solution: Site a landfill wisely.

Any sludge disposal alternative is going to require a landfill for the grit and screenings that are removed from wastewater during treatment and that cannot be disposed of in any other way. The landfill requirements of incinerator ash would be a small addition to this landfill. A properly sited landfill can be made with a buffer of trees and open space around it that would insulate it from its surroundings.

Incinerators

Problem	Solution
Air pollution	Stop problem pollutants before they get into the sludge. Use state-of-the-art pollution control.
Threat to groundwater from ash leachate	Build a secure landfill.
Landfill siting	Make a landfill a safe neighbor.



Composting

What is sludge composting?

Sludge is made up primarily of human waste and other organic material. When sludge is composted, harmless bacteria that are already in the sludge are allowed to multiply and break down the waste converting it into a useable soil conditioning product. It is the same process used in people's backyard compost piles.

What purposes does composting serve?

- It kills viruses and harmful bacteria present in the sludge.
- It reduces the amount of certain organic pollutants in the sludge.
- It produces a useful product that can be marketed for horticultural or land scaping purposes.

What are the advantages of composting?

Composting is a proven technology. Two types of technology are currently used to compost sludge. Reactor systems convert sludge to compost inside an enclosed vessel. Nonreactor systems compost sludge in unenclosed areas. The reactor systems tend to control odors better, but are more expensive to build and operate than the nonreactor systems.

Sludge composting facilities are operating throughout the United States. At the time of a 1985 survey by Biocycle magazine, there were 79 operating sludge composting facilities in the U.S. and Puerto Rico. Since that time many more communities have turned to sludge composting as a disposal method.

The primary problem caused by composting is odor. The technology to control composting odor is relatively simple. It involves filtering the air to remove odor causing materials.

Both federal and state agencies have regulations in place that must be applied to sludge composting operations. The Massachusetts Department of Environmental Management (DEM) has guidelines that control the uses of sludge-derived compost and set strict standards for the allowable concentrations of heavy metals and organic compounds in compost. Each composting facility must have a permit from the state before operation can begin. The composting facility is monitored by a state agency to ensure all federal and state regulations are followed.

Composting converts a waste into a resource. Sludge-derived compost is a high quality soil conditioner. It improves the ability of soil to hold moisture, provides a natural growing medium and contains valuable plant nutrients.

Composting can be rapidly implemented. Sludge composting facilities can be designed and built in a fairly short period of time.

What are problems with composting and how can they be solved?

Any method that is used to dispose of sludge, including composting, will have some environmental impacts. However, there are ways to reduce or eliminate these potential problems. Rigorous wastewater quality enforcement, careful design and responsible operation of composting facilities are necessary to minimize the environmental impacts. What follows is a list of some concerns about sludge composting and descriptions of the best ways to respond to those concerns.

Problem: Sludge smells.

If not properly aerated, composting sludge can produce objectionable odors. These odors can be a serious nuisance for nearby residents.

Solution: Aerate the sludge, capture and treat the emissions.

Odor problems usually occur when sludge does not get enough air while it is composting. Oxygen is required by the bacteria to properly compost the sludge. Improving air circulation in the compost by forcing air through it often helps. The use of a reactor-type composting system, which is fully enclosed, would facilitate the collection and treatment of the gases produced during composting.

Problem: Sludge can be contaminated.

Chemicals that get into the sewerage system from industries, businesses and homes can be concentrated in sludge during the process of removing it from liquid sludge. Trace pollutants such as metal compounds (copper, mercury, cadmium, etc.) and certain organic compounds (PCBs, pesticides, etc.) will be concentrated in the sludge if they are present in the wastewater. If these compounds enter the food chain and are ingested by humans in high enough concentrations, they can be quite harmful.

Solution: Stop pollutants before they get to the treatment plant.

One of the best ways to reduce the amount of problem materials in sludge (and therefore in sludge compost) is by encouraging industries and households to significantly reduce the amount of these materials that are discharged into the sewerage system.

Solution: Regulate the uses of compost.

State and federal guidelines for compost set limits for heavy metals and organic compound concentrations at levels that will not harm ground water, surface water or public health.

Problem: Compost nutrients could contaminate groundwater.

Sludge compost is rich in soluble nitrates. These compounds are dissolved by rain water that fall on applied compost. They can then rinse through the soil and may end up in groundwater. While nitrates are good for plants (their presence helps to make sludge compost a good fertilizer), they can cause health problems for people if they reach high concentrations in drinking water. The same problems occur if too much synthetic fertilizer is applied to a field or lawn.

Solution: Control compost application rates.

Because nitrates are important plant nutrients, they are rapidly consumed by vegetation. Nitrates will not leach through the soil if they are quickly used by plants. To prevent groundwater contamination, compost and fertilizer should only be applied at rates that will provide the nutrients needed by the plants.

Problem: Leachate could contaminate water.

Composting produces a small amount of liquid drainage residue called leachate/ condensate. The quantities are extremely small, as little as 5 gallons per ton of composted sludge. This leachate could pollute a body of water with water soluble nitrates and phosphorus.

Solution: Collect and treat leachate.

All composting facilities throughout the United States collect and recycle the compost leachate back to the treatment plant for treatment. This method treats the leachate/condensate as part of regular wastewater flow to the treatment plant.

Composting

Problem	Solution
Odors	Aerate compost. Treat odors.
Compost contamination (metals, organic compounds)	Stop problem pollutants before they get into sludge. Regulate compost use.
Threat to groundwater	Control compost application rates.
Compost leachate	Collect and treat leachate.

Pelletizing (Heat Drying)

What is pelletizing?

The pelletizing process involves the removal of moisture from sludge through evaporation to form small, solid particles called pellets. The pellets can be distributed for use as a fertilizer and/or soil conditioner.

What purposes does pelletizing serve?

- It kills viruses and bacteria which are present in the sludge.
- It creates a useful product that can be marketed as a fertilizer and/or soil conditioner.
- It offsets some of the processing costs.
- It reduces the volume of material that must be transported.

What are the advantages of pelletizing?

Sludge pelletizing is a proven technology. Milwaukee has been successfully selling their sludge pellets for over sixty years. Other cities throughout the country that are selling their sludge as fertilizer and soil conditioners include Philadelphia, Chicago, Baltimore and Washington, D.C..

Regulatory agencies have established procedures for ensuring that all sludge facilities, including heat-dried pelletizing plants receive a full environmental review before they are constructed.

Some of the processing costs involved can be offset by the sale of fertilizer pellets.

Pelletizing of sludge can be implemented rapidly since these facilities can be designed and built in a fairly short period of time.

Pelletizing converts a waste into a resource. Dried sludge products are high quality soil conditioners and fertilizers. Returning organic material to soils preserves soil structure.

Organic fertilizers such as sludge pellets provide a solution to nutrient pollution often caused by chemical fertilizers. Nutrient pollution occurs when high concentrations of nitrogen or phosphorus flow into surface waters, such as streams, ponds and lakes, fostering the growth of algae. An overabundance of algae uses up oxygen in the water, virtually suffocating aquatic life. With organic fertilizers, the release of nutrients is much slower, leaving more nutrients for plants and less for nutrient runoff.

What are the problems with pelletizing sludge and how can they be solved?

Any method that is used to dispose of sludge, including pelletizing, will have some environmental impacts. However, there are ways to reduce or eliminate these potential problems. Rigorous wastewater quality enforcement, careful design and responsible operation of pelletizing facilities will be necessary to minimize the environmental impacts. What follows is a list of some concerns about the heat drying pelletizing process of sludge and descriptions of the best ways to respond to those concerns.

Problem: Sludge could be contaminated.

Chemicals that get into our sewerage system from industries, businesses and homes can be concentrated in sludge during the wastewater treatment process. Trace pollutants such as metal compounds (copper, mercury, cadmium, etc.) and certain organic compounds (PCBs, pesticides, etc.) will be concentrated in the sludge if they are present in the wastewater. If these compounds enter the food chain and are ingested by humans in high enough concentrations, they can be quite harmful.

Solution: Stop pollutants before they get to the treatment plant.

One of the best ways to reduce the amount of problem material in sludge (and therefore in the heat-dried sludge pellets) is by encouraging industries and households to significantly reduce the amount of these materials that are discharged into the sewage system.

Solution: Regulate the uses of fertilizer pellets.

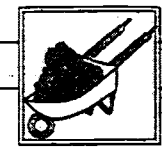
To qualify for use as a fertilizer, sludge pellets must meet strict federal and state quality guidelines. State and federal guidelines for dried sludge products set limits for heavy metal and organic compound concentrations that will not harm groundwater, surface water or public health. Monthly monitoring reports are required to ensure ongoing compliance or alert officials to potential problems.

Problem: Pelletizing of sludge produces air pollution.

Although the vast majority of emissions from a pelletizing facility would be simple water vapor, pelletizing facilities also produce small particles of dried sludge that could be harmful if released in large quantities. Odors have also been considered a problem of pelletizing facilities.

Solution: Treat sludge dryer emissions.

Emission "scrubbers", filtering equipment and odor control technologies can



minimize air pollution problems at sludge pelletizing facilities. The "scrubbers" trap fine particles ensuring that they will not be released into the atmosphere. By completely enclosing the dryers, offensive odors can also be contained.

Pelletizing

Problem	Solution
Dried sludge contamination (metals, organic compounds)	**Stop problem pollutants before they get into the sludge. Regulate the use of sludge pellets.**
Air pollution and odor	**Construct all dryer and building ventilation with the best available control technology to remove and/or destroy odor and prevent air pollution.**

Landfills

What is landfilling?

Landfilling is a sludge disposal method in which sludge is deposited in a dedicated area, alone or with solid waste and buried beneath a solid cover.

What purposes do landfills serve?

- They are a final disposal site for sludge and other residuals.
- They can be used for other purposes after they have reached their capacity.
- They can be designed for "co-disposal". (In co-disposal, wastewater sludge is deposited in a landfill together with municipal solid waste. In this way, the absorption characteristics of the solid waste and the soil conditioning characteristics of the sludge can complement each other.)

What are the advantages of landfills?

They are a proven technology. Landfills have been with us for a long time. Seventy-five percent of sewage sludge generated in Massachusetts is disposed of in landfills. In recent years, an understanding of the best ways to design and operate landfills has improved dramatically. If properly designed, landfills are a safe way to dispose of residuals.

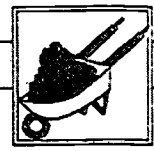
They are reliable and relatively inexpensive overall. Much of the cost of a modern landfill is the initial design and construction expense. Once built, landfills are inexpensive to operate.

Landfills confine wastes to a certain area. Unlike discharging wastes into the air or water, modern landfills contain the wastes in an easily monitored area. Landfills are currently designed to prevent pollutants from leaving the site. For example, leachate is collected so it does not reach groundwater.

If landfilling operations are properly planned and executed, a completed landfill site can be sold or used by the municipality for other purposes, such as recreational space.

What are the problems with landfills and how can they be solved?

Landfills have some environmental impacts. However, there are ways to reduce or eliminate these potential problems. Care in design and operation of a landfill will minimize environmental impacts. What follows is a list of some con-



cerns about landfills and descriptions of the best ways to respond to those concerns.

Problem: Finding a place to put a landfill.

Few people want to have a landfill in their backyards. Recent debates about whether sludge and sludge ash are hazardous have heightened people's concerns about where to site landfills.

Solution: Make landfills safe.

State and federal regulators require landfills to be designed and operated in ways that prevent environmental damage and insulate neighboring lands from harmful impacts. In Massachusetts, the Department of Environmental Management, DEM, is responsible for regulating the construction and operation of landfills and prohibits the construction of landfills that threaten the health of people or the environment.

Problem: Sludge landfills smell.

Odors, while not a known health hazard, can be among the most serious concerns for people who live near a landfill.

Solution: Use good landfill "housekeeping" to control odors.

Material that is deposited in landfills is required to be covered with soil daily to contain odors. According to Massachusetts state regulations, landfills must be buffered from neighboring land uses.

Problem: Landfills can pose a health threat.

Many people are concerned that sludge poses a health threat to neighbors because of disease-causing organisms.

Solution: Neutralize disease-causing organisms.

Organisms which might possibly be in the sludge will be isolated from the environment by burying them daily under soil. Organisms die off over time when buried. Federal and state regulations require organisms to be controlled as part of the safe operation of a landfill.

Problem: Landfills threaten groundwater.

Whenever it rains, water can percolate through a landfill and dissolve some materials in the waste. This water, now called "leachate", can seep through the subsoil and pollute groundwater.

Solution: Line the landfill.

Modern landfills in Massachusetts are required to have two "liners" which are layers of clay or synthetic waterproof material that prevent leachate from seeping out of the landfill and into the groundwater. In addition, newly-permitted landfills must have a leachate collection system that removes the leachate from the liner so that it can be discharged to the sewerage system for treatment. Finally, groundwater monitoring is required on a regular basis, both on and around the site, to ensure that these protective measures are effective.

Landfills

Problems	Solution
Siting	**Make landfills a safe neighbor.**
Odors	**Control odors with daily soil cover. Buffer neighbors.**
Health concerns	**Bury residuals daily.**
Threat to groundwater	**Use impermeable landfill liners. Collect and treat leachate.**

Lesson 6

Purpose:

To impress upon students the importance of using a product correctly.

Lesson in brief

Students are given three situations in which the application of sludge pellets is involved. The students must figure out mathematically the proper amount of pellets which should be applied.

Key words and concepts

Fertilization can greatly enhance the growth and health of crops, pastures, lawns and garden. If too much fertilizer is applied, the plants cannot absorb all the available nutrients and the excess may leach into groundwater or run off into streams or storm drains.

Fertilizer Sludge

Materials

Worksheets.

Note: The step-by-step solution is provided for problem 1. Depending on your students knowledge of math, you may choose to provide them with this information as a guide in calculating the solution to Problem 2 and Problem 3. If providing students with the solution to problem 1, use Worksheet A. If not, use Worksheet B.

Preparation

Introduce information contained in the background information prior to giving the students the worksheets.

Time Required

One class period.

Background information

Sludge in the 1990s

On December 31, 1991 the MWRA will cease to be one of the nation's last remaining ocean dumpers of sewage sludge and become one of the largest generators of heat-dried fertilizer pellets.

Sludge fertilizer isn't a new idea. The Chinese have used human waste for thousands of years. The Japanese called it "nightsoil" and used it as a fertilizer on

orchards and gardens. Closer to home, Milwaukee has packaged its sludge as Milorganite for over sixty years, and sells it nationwide. It seems that sludge fertilizer is an old idea every place but Boston.

Before the 1940s, land application of sludge was common in the United States. But as soon as synthetic fertilizers became more economical and widely available, sludge was seen as a useless material -- something to be disposed of. In New England, sludge has been dumped in the ocean, landfilled and incinerated. After years of throwing away our waste material (and polluting the ocean in the process), Boston and other cities around the country are finally waking up. Philadelphia, Seattle, Chicago, Baltimore and Washington, D.C. are all selling their sludge as fertilizers and soil conditioners.

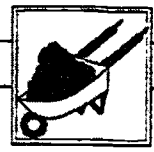
Is sludge fertilizer safe?

Wastewater entering the treatment plant is 99.5% water. Only 0.5% of the wastewater is solid material that contains the organic material, fertilizer nutrients, metals, bacteria and chemicals that collectively are called contaminants. A contaminant is any unwanted material that makes something impure, unclean, or unsuitable for a desired use. The contaminating solids must be removed from the wastewater before the "clean" water can be discharged to a river or ocean.

Many of the bacteria in the wastewater solids are disease-causing organisms called pathogens. Most of the pathogens are killed in the wastewater treatment process. The separated solids are called sludge. When the sludge is dried by heat to make fertilizer pellets, 99% or more of the remaining pathogens in the sludge are destroyed.

Sludge often contains heavy metals. Some heavy metals, such as zinc and copper, are required for plant growth and are called plant micronutrients. At high concentrations, some heavy metals can make sludge unusable as a fertilizer. The wastewater treatment process does not remove metals from the sludge. The best way to have good "clean" sludge is to limit industrial discharges of metals and toxic chemicals into the waste system in the first place.

Boston's sludge has relatively low concentrations of heavy metals for several reasons. First, industrial discharges to our sewer system represent only a small fraction of the volume of wastewater from the whole MWRA service area. Second, most industrial facilities that discharge to the sewer system are required to pretreat their wastewater. This means that they must remove most of the contaminants from their effluent before it reaches the sewer system.



Finally, the MWRA has a Toxic Reduction and Control (TRAC) Department. This department employes inspection teams to monitor industrial facilities to make sure that they are not discharging contaminants in excess of permitted limits. When they do find a company that's polluting our waste stream (and, therefore, our sludge), the company is fined heavily. Thus, if companies need an incentive to be environmentally responsible, the MWRA fines make it a matter of economics.

What About the Sludge at the Botton of the Harbor?

Many people use the term "sludge" to refer to the contaminated sediments on the bottom of Boston Harbor. This is somewhat imprecise, since these sediments were contaminated by more sources than just the wastewater treatment process byproduct that we call sludge. **THERE ARE NO PLANS TO DREDGE BOSTON HARBOR SEDIMENTS.** The material on the bottom of the harbor will remain there, and it is anticipated that it will be covered naturally by clean sediments in the coming decades.

MWRA FERTILIZER WILL ONLY BE MADE FROM FRESH, TREATMENT PLANT SLUDGE. This will allow the MWRA to stop dumping the sludge in the ocean. There will be no contaminated harbor sediments used in the fertilizer pellets.

Appropriate Use of Fertilizer

When farmers or home gardeners grow crops or plants that require more nutrients than are available in the soil, they add additional nitrogen, phosphorus or other nutrients in the form of natural or synthetic fertilizers. Fertilization can greatly enhance the growth and health of crops, pasture, lawns, and gardens. However, if too much fertilizer is applied, and the plants can not absorb all the available nutrients, the excess may leach into groundwater or run off into streams or storm drains. From there, the nutrients may join water destined for wastewater treatment plants or Boston Harbor. (Pesticides can also reach the Harbor this way.)

Excess nutrients in streams, rivers, lakes, or the Harbor can alter the chemical and biological conditions of those fresh or salt water environments. For example, algae that directly consume the nutrients may bloom dramatically, creating floating mats that block sunlight from penetrating the surface of the water. The algae also consume much of the dissolved oxygen in the water. Changes in the levels of oxygen and sunlight can significantly affect the species of plants and

animals that live below the surface. Some species may disappear, while others flourish. As a result, the whole ecology of a body of water may change.

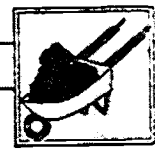
By using only the amount of fertilizer needed to meet the nutrient requirements of a crop or lawn, the risk of nutrient pollution to ground or surface waters is greatly reduced. One of the most important factors in determining the appropriate rate of application is the nitrogen requirement of the plant to be grown. Not only is the total amount of nitrogen important, but so is the timing of the application. If all the nitrogen is applied at once, plants will develop quickly, but the nutrient reserves in their roots will be depleted. The roots will be weakened and the long-term health of the plants will be hurt.

For New England lawns, fertilizer specialists recommend using a product like the MWRA pellets three times during the growing season. One application in late May provides the grass with the nutrients it will need throughout the summer. Two applications in the fall help the plants develop healthy root systems, store nutrients to nourish them through the winter, and help them get a good start in the spring. At the recommended rates of application, the lawn takes up enough of the nutrients so that practically none will run off during a heavy rain or leach into the groundwater.

Research Projects

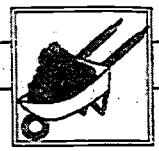
Sludge has been applied to land in many other parts of the country and has been studied intensively. However, every sewerage district's sludge is different, and the soil, hydrology, and other environmental attributes of New England are unique to the area. Because of the lack of practical, hands-on experience with the application of sludge in this region, agricultural research and demonstration projects are an important part of building a sludge recycling program. The research aims to establish both the environmental suitability of our sludge for local applications and the product performance of sludge pellets as an nutrient supplement and soil conditioner.

The MWRA is participating in a multi-state research project organized by the U.S. Department of Agriculture to study the use of sludge products in silviculture (commercial forestry and timber production). Various other types of sludge research are underway, including studies of turf grass and commercial sod production, land reclamation (using sludge to rebuild topsoil), and growing Christmas trees and other ornamental plants.



FERTILIZER CALCULATION WORKSHEET
Answer Sheet

	Example 1	Example 2	Example 3
A. Total Area of Property (sq ft)	12,000	105,000	15,000
B. Area with NO Lawn (sq ft)	2,000	65,000	314
C. Area of Lawn (sq ft) A - B	10,000	40,000	14,686
D. Pounds of Nitrogen Needed per Application C / 1000	10	40	14.7
E. Pounds of Pellets Needed per Pound of Nitrogen 1 / nitrogen content	20	20	20
F. Pounds of Pellets Needed per Application D x E	200	800	294
G. Bags of Pellets Needed per Application F / 40	5	20	7.35
H. Bags of Pellets Needed per Growing Season G x 3	15	60	22

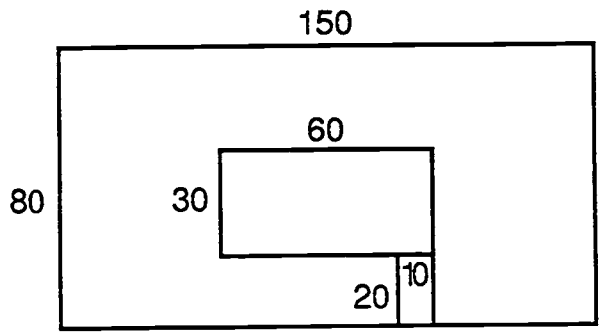


Problem 1:

A homeowner wants to use fertilizer pellets to improve her lawn. She has been advised that she should apply one pound of nitrogen per 1000 square feet of lawn, three times per growing season (that is, three pounds per 1000 sq ft over the whole growing season).

This homeowner's total property measures 80 feet by 150 feet (see diagram). Her house takes up 30 ft x 60 ft, and her driveway occupies an additional 20 ft. by 10 ft. The remainder of the property is lawn.

Analysis of the fertilizer pellets has shown that they are 5% nitrogen, by weight. The pellets are sold in 40 lb. bags. How many bags should this homeowner buy to fertilize her lawn?



Solution 1:
The accompanying worksheet will help you reach your answer.
A, B, and C (on worksheet): We first need to know how many square feet of lawn there are.

Area of lawn = total area - (area of house + area of driveway)
(C) = (A) - (B)

= (80' x 150') - [(30' x 60') + (10' x 20')]

= 12,000 sq ft - (1800 sq ft + 200 sq ft)

= 10,000 sq ft

D. How many pounds of nitrogen will she need for each application?

Let N be the number of pounds of nitrogen needed

$$\frac{\text{1 pound nitrogen}}{\text{1000 sq ft}} = \frac{\text{N pounds nitrogen}}{\text{10,000 sq ft}}$$

$$10{,}000 = 1000N$$

$N = 10$

For each application, 10 lbs of nitrogen are needed.

E. Now, how many pounds of fertilizer pellets will be needed to obtain 10 pounds of nitrogen?
First, we can figure out how much pellet fertilizer we need to obtain one pound of nitrogen. Since the pellets are 5% nitrogen,

pounds of pellets x .05 = pounds of nitrogen

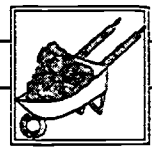
Let P be the number of pounds of pellets containing one pound of nitrogen.
Then,

P x .05 = 1 pound of nitrogen

$$P = \frac{1}{.05}$$

$P = 20$

We need 20 pounds of pellets to get one pound of nitrogen.



F. Now, how many pounds of pellets will provide 10 pounds of nitrogen?

10 lbs of nitrogen x 20 lbs of pellets =
per lb of nitrogen

200 lbs of pellets

G. How many 40-lb bags of pellets will the homeowner need to buy for each application?

200 lbs / 40 lbs per bag = 5 bags

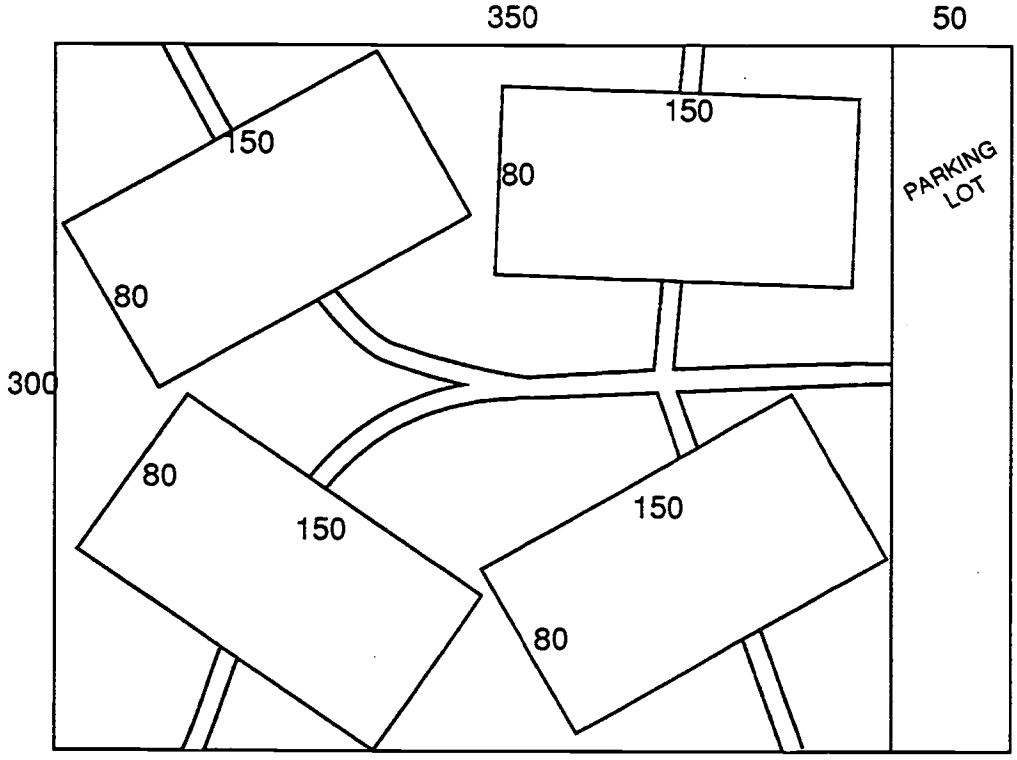
H. How many bags will she need for the whole growing season?

Since three applications are required, she will need 5 x 3 = 15 bags of pellets.

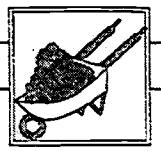
Problem 2:

Now imagine that you are the groundskeeper for a block of apartment buildings. The dimensions of the whole property are 350' x 300'. There are four buildings and one parking lot on the property. Each apartment building measures 80' x 150' and the parking lot measures 300' x 50'. The paved paths connecting the buildings and parking lots take up an additional 2000 sq ft. The rest of the property is lawn.

Assume again that fertilizer pellets are 5% nitrogen, and that you need 3 applications of 1 pound nitrogen per 1000 sq ft. How many 40 lb bags of pellets will you need to buy?



PATHS = 2,000 SQ. FT

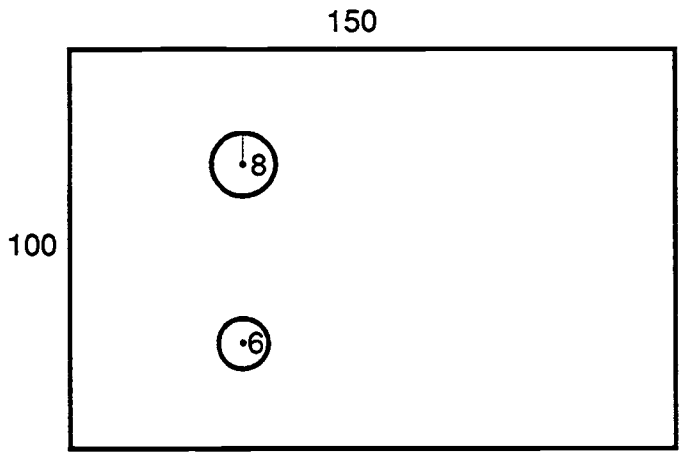


Problem 3:

This time you are responsible for the grass in a playground. The total area measures 100' x 150'. The playground has a merry-go-round in one corner, and a jungle gym in another. Both these pieces of equipment have sand underneath them on which no grass is grown. The merry-go-round takes up a circular space with a radius of 6 feet. The jungle gym area is also circular, with a radius of 8 feet.

How many pounds of fertilizer will you need for the playground? How many bags?

Helpful Hint: The formula for the area of a circle is pi x r2. Pi = 3.14 (approximately). Round off your total area to a whole number before going on. Answers will vary slightly according to how you decide to round off.



FERTILIZER CALCULATION WORKSHEET (A)

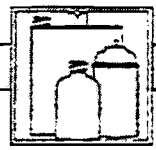
	Example 1	Example 2	Example 3
A. Total Area of Property (sq ft)	12,000		
B. Area with NO Lawn (sq ft)	2,000		
C. Area of Lawn (sq ft) A - B	10,000		
D. Pounds of Nitrogen Needed per Application C / 1000	10		
E. Pounds of Pellets Needed per Pound of Nitrogen 1 / nitrogen content	20		
F. Pounds of Pellets Needed per Application D x E	200		
G. Bags of Pellets Needed per Application F / 40	5		
H. Bags of Pellets Needed per Growing Season G x 3	15		

FERTILIZER CALCULATION WORKSHEET (B)

	Example 1	Example 2	Example 3
A. Total Area of Property (sq ft)	_____	_____	_____
B. Area with NO Lawn (sq ft)			
C. Area of Lawn (sq ft) A - B	_____	_____	_____
D. Pounds of Nitrogen Needed per Application C / 1000	_____	_____	_____
E. Pounds of Pellets Needed per Pound of Nitrogen 1 / nitrogen content	_____	_____	_____
F. Pounds of Pellets Needed per Application D x E	_____	_____	_____
G. Bags of Pellets Needed per Application F / 40	_____	_____	_____
H. Bags of Pellets Needed per Growing Season G x 3	_____	_____	_____

Part 3

Introduction



INTRODUCTION: GETTING TOUGH ON TOXINS

Hazardous products are virtually everywhere, including our homes. Paint, toilet bowl cleaners, pool chemicals, used motor oil and pesticides are just five examples of hazardous products commonly found in our homes. Careless or excessive use and improper disposal of these and other household hazardous products can be harmful to the environment and to human health.

The effects associated with the *improper use* of household hazardous products can range from those which are relatively minor -- eye and throat irritations, headaches, dizziness, nausea, etc. -- to more serious problems such as skin rashes and burns, liver or kidney damage, cancer, birth defects and even death. The effects associated with the *improper disposal* of household hazardous products can include the contamination of air and water resources, disruption of wastewater collection and treatment systems and injury to solid waste handlers and sewage system workers.

The dangers posed by the improper use and disposal of household hazardous products can be significantly diminished. Product substitution and safe disposal are the most effective strategies that we can use to reduce the damage caused by household hazardous products.

By using less harmful alternatives to household hazardous products, we not only end up with safer homes and a cleaner environment, but we also save the expense of buying costly consumer products. By taking the time to dispose of household hazardous products properly, we not only help to reduce their potential danger to our health and environment, but also the expense of environmental clean-up.

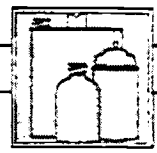
As the operator of a sewerage system that handles the waste of over 2.1 million people and 5,500 businesses and industries in 43 communities in Eastern Massachusetts, and as overseer of the Boston Harbor Project, the Massachusetts Water Resources Authority is particularly concerned about the environmental problems associated with household hazardous products. When mulitiplied by 2.1 million people, the use and disposal of even small amounts of household hazardous products on an individual basis can add up to a significant contribution of toxic chemicals and heavy metals to the MWRA system. Many toxic chemicals and heavy metals cannot be fully removed by sewage treatment. When released

into the MWRA system, these pollutants flow through the Deer Island and Nut Island Treatment Plants and into Boston Harbor, where they can accumulate in the sediment which is the feeding ground for the harbor's marine life. They can eventually work their way up the food chain, becoming more and more concentrated each step of the way. This process, known as "bio-magnification," causes the highest concentrations of contaminants to occur in animals near the top of the food chain.

The organic chemicals and heavy metals found in household hazardous products can also concentrate in the sludge which is an end product of sewage treatment. High levels of contaminants, such as those that may result from household hazardous products, can limit sludge reuse options.

A primary responsibility of the MWRA Toxic Reduction and Control Department (TRAC) is to reduce and control the types and amounts of pollutants that enter the MWRA's sewerage system. To fulfill this responsibility, TRAC is implementing a wide range of programs for individuals, businesses and industries to develop safe and responsible hazardous material use and disposal practices. Underlying these programs is a strong education effort which includes instruction for the general public as well as school-age groups. TRAC's household hazardous waste education efforts stress that by the choices we make in our own homes, each and every one of us has an impact on our environment. By "Getting Tough on Toxins," we can all help to protect the environment and public health.

Lesson 7



What are Household Hazardous Products and Household Hazardous Waste?

Purpose:

To increase student awareness of household hazardous products and the possible impacts of their use and disposal on the environment and public health.

Lesson in brief

Students are asked to read a short introduction to household hazardous products and to come prepared to discuss it in class the next day. Students and teacher discuss the reading assignment and apply it to a set of problems regarding the disposal of household hazardous waste.

Key words and concepts

Hazardous products are everywhere, including our homes. Many of these products, when used or disposed improperly, pose serious threats to the quality of our environment and public health. As consumers of hazardous products, each and every one of us plays a role in either advancing or impeding the development of a cleaner and safer world. It is important to make students aware of this relationship at a time when their habits as consumers are still in the process of being formed.

Absorption	Chemical	Ingestion	Storm Drains
Acute Effects	Chronic Effects	Inhalation	Waste
Bio-magnification	Hazardous	Solvent	

Materials

- "Household Hazardous Waste Guide"
- "The Disposal Dilemma"

Time required

One class period, plus homework assignments.

Preparation

1. Read the introductory "Household Hazardous Waste Guide" and review "The Disposal Dilemma" and its accompanying "Decision Matrices" and "Product Tables".

2. Make enough copies of the "Household Hazardous Waste Guide" and "The Disposal Dilemma" to distribute to your students.

3. Distribute the "Household Hazardous Waste Guide" as a homework reading assignment, prior to performing this lesson.

Procedure

1. Introduce the subject of household hazardous products/waste by leading a discussion of the material covered in the "Household Hazardous Waste Guide."

   Ask your students:

   "Who can describe what it means for a product to be hazardous?"

   "Can anyone list three products in their home that are hazardous? Did you know they were hazardous before reading the assignment?" "If 'yes', then how did you know?"

   "What should you look for on a product to identify whether or not it is hazardous?"

   "What are the four steps you can take to reduce the potential for household hazardous products to threaten or harm human health or the environment?"

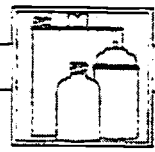
2. Discuss with your students their own experiences with the use and disposal of household hazardous products.

   Ask them:

   "How often do you think we and our families use hazardous products in our homes: More than once a day? More than once a week? Less than once a week, etc.?"

   "What do we use these products for?" ***(We use them to clean our homes, keep our cars running smoothly, to make our lawns and gardens look better, etc.)***

   "Why do we use these product if we know that they can possibly harm our environment and our health?" ***(They make our lives easier. In an age where leisure time is a precious resource, we have become accustomed to relying on "convenience products" which offer easy solutions to maintaining our homes/lawns/gardens. We have been taught by commercials and other forms of advertisement that those***



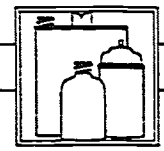
products which promise us more time, less effort and "more shine" are an essential part of our life, etc.)

"How do we typically dispose of these products?" ***(Students may relate stories of particular instances in which they, or someone they know, has poured a hazardous product on the ground, thrown one in the trash or poured one down a sink or storm drain.)***

3. Divide the class into small groups and distribute one copy of "The Disposal Dilemma" to each group. Ask each group to work on all three problems and to share their conclusions with each other at the end of a given time period. Or, if time is short, each group may be assigned only one of the three problems and present conclusions at the end. As the groups deliberate, they should keep track of their discussion and decisions on the "Decision Matrices" included in "The Disposal Dilemma".

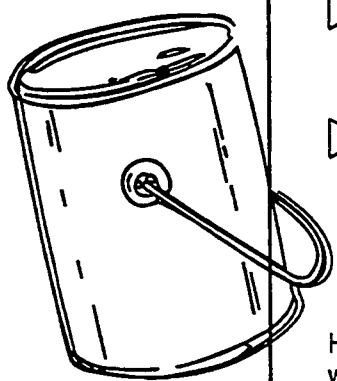
   Remind students that these are **current issues**. **Current**, because in the last few years we have only begun to recognize the danger of failing to exercise caution in our use and disposal of chemicals. **Issues**, because there are many positions people can take. We simply don't know the chemical make-up of many household products or the effects of many chemicals. All household disposal options have some degree of risk if the chemical is toxic or severely persistent. Alternatives to disposal and use of household chemical products raise the usual controversies between private sector and public sector, including those about who is responsible and who should pay.

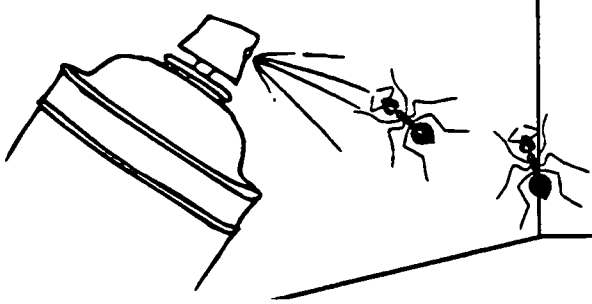
Parts of this lesson adapted from *"Sleuth: Educational Activities on the Disposal of Household Hazardous Waste"*. Metro Toxicant Report No ID, Aug., 1982. Water Quality Division, Municipality of Metropolitan Seattle.



Guide to Hazardous Products in your Home

SECTION 1: What are Household Hazardous Products and Household Hazardous Waste?





A household hazardous product is one which can threaten or harm human health or the environment when used or disposed improperly. When left-over or unused portions of household hazardous products become something that somebody no longer wants or has a use for, they become known as household hazardous waste.

What Makes a Product/Waste Hazardous?
A household product or waste is considered hazardous when it contains any substance or mixture of substances which has one or more of the following characteristics:

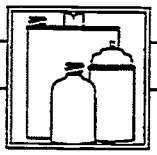
- ***Toxic/Poisonous:*** Capable of causing injury or death through ingestion, inhalation or skin absorption.
- ***Corrosive:*** Can eat away materials and living tissue by chemical action.
- ***Explosive/Reactive:*** Can react with air, water or other substances and result in explosions and the generation of toxic fumes.
- ***Flammable/Combustive:*** Can undergo spontaneous combustion at relatively low temperatures, thereby presenting a significant fire hazard.

Effects of Household Hazardous Products and Household Hazardous Waste:

Household hazardous products and household hazardous waste can produce two types of effects on human health and the environment: acute and chronic.

• Acute effects are those which can occur immediately. Skin burns or blindness caused by splashing battery acid, a fire caused by gasoline that is stored too close to a wood stove or a fish kill caused by pouring a pesticide down a storm drain are examples of acute effects caused by hazardous products.

• Chronic effects are those which can occur through repeated exposure to a substance over an extended



Guide to Hazardous Products in your Home

period. Examples include depression, dizziness, irritability, liver or kidney damage, cancer and the slow degradation of a lake or stream resulting from the repeated disposal of small amounts of toxic products down a storm drain over time.

How to Identify Household Hazardous Products
You can identify a hazardous product by reading the label. You can assume that a product is hazardous if its label bears one or more of the followin signal words:

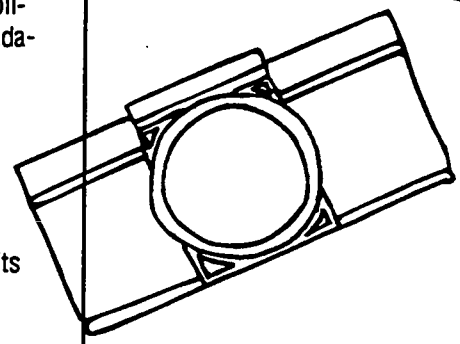
"POISON" "DANGER" "WARNING" "CAUTION"

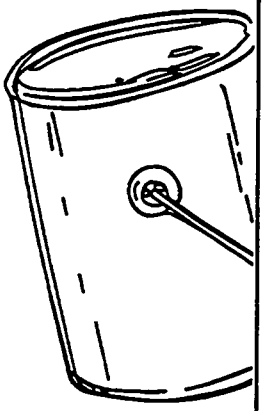
These are federally-mandated words that must appear on the labels of products that demonstrate an acute (immediate) health effect due to the result of a hazardous ingredient.

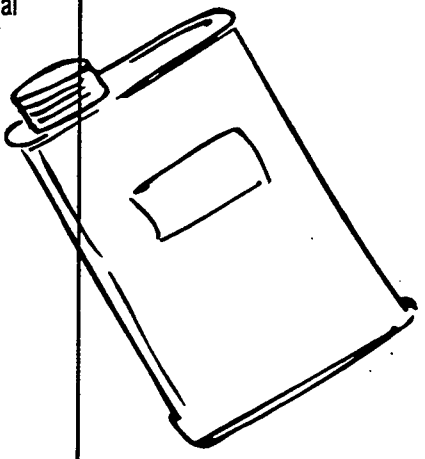
With pesticides, ***"DANGER"*** means highly toxic; a taste to a teaspoon could be fatal. ***"WARNING"*** means moderately toxic; a teaspoon to an ounce could be fatal. ***"CAUTION"*** signals slight toxicity; an ounce to a pint could be fatal.

With other household products, ***"POISON"*** means highly toxic and ***"DANGER"*** means extremely flammable, corrosive or highly toxic. ***"WARNING"*** or ***"CAUTION"*** appear on all other hazardous substances. These signal words are usually followed by the words, "Keep out of reach of children."

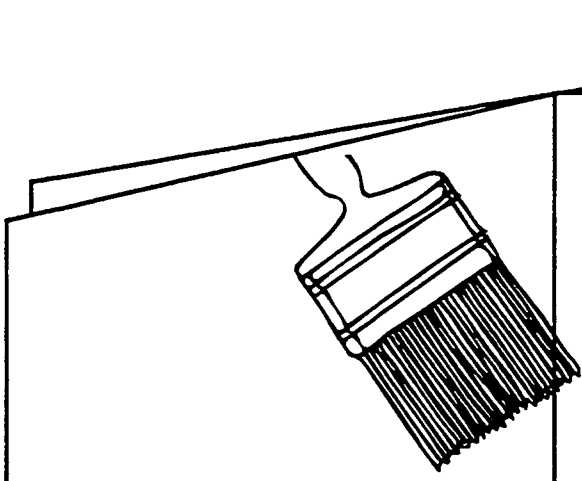
Other clues that a product is hazardous include:
- A description of the hazard(s) involved in using the product. Example: "Flammable;" "Vapor Harmful;" "Harmful if Swallowed."
- A statement of how to avoid the hazard. Example: "Use in well-ventilated room."
- First Aid instructions.



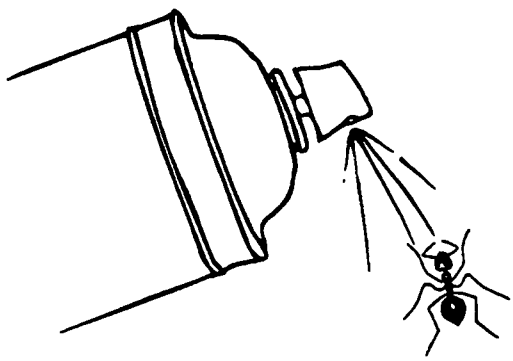


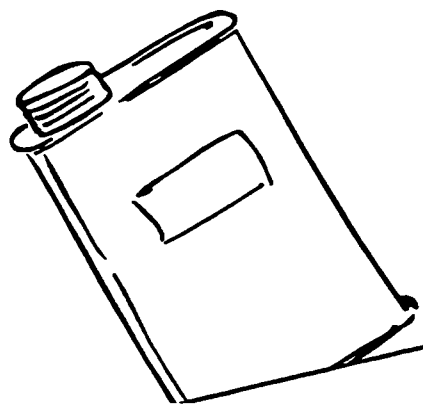


Guide to Hazardous Products in your Home



SECTION 2: What can you do about Household Hazardous Waste





Common Hazardous Products In Your Home
Most household products can be grouped into five basic categories: Paints & Solvents, Pesticides, Household Cleaners, Automotive Products and Other.

Common Examples include:

Oil based paint	Paint strippers	Paint thinners
Metal polish	Photo chemicals	Chemical fertilizers
Spot remover	Shoe polish	Weedkillers
Insecticides	Brake fluid	Toilet bowl cleaner
Rat poison	Ant/Roach spray	Flea spray/collars
Lighter fluid	Mothballs	Air fresheners
Drain cleaner	Oven cleaner	Disinfectants
Pool chemicals	Degreasers	Aerosol sprays
Deodorizers	Floor cleaner/wax	Used motor oil
Antifreeze	Gasoline	Car batteries

The harmful effects of household hazardous products stem from three distinct actions:

(1) product purchase **(2)** product use and **(3)** waste disposal.

You can prevent or reduce much of the damage caused by household hazardous products by following four basic practices:

Source Reduction
Proper Use
Reuse/Recycling
Safe Disposal

Source Reduction
The first step you can take to prevent or reduce the damage caused by household hazardous products is to minimize their use.

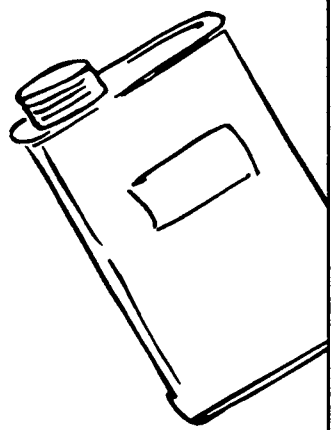
Source Reduction Suggestions:
• Buy only as much of a hazardous product as you really need. Purchase the smallest size container that can do

the job.
• Avoid hazardous products whenever you can. Use safer alternatives as often as possible.
• Put commonly available safe substances to other uses. For example, vinegar, baking soda and club soda have many cleaning uses.

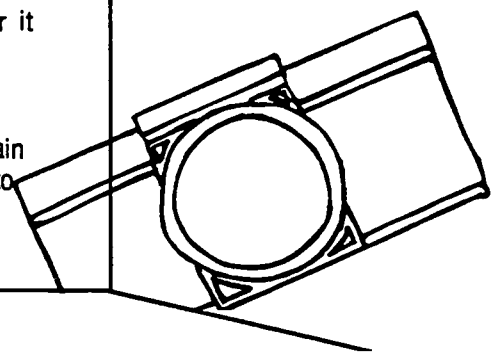
Proper Use
The second step is to handle household hazardous products carefully and use them wisely.

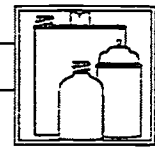
Although many of the effects associated with the improper use of household products are relatively minor- headaches, dizziness, nausea, skin rashes, nose and throat irritations, etc. Others are much more serious, including eye injury, liver or kidney damage, cancer or even death.

Proper Use Suggestions:
• Read the label and follow its directions!
• Remember that **"more"** is not always **"better"**. Use only as much of a product as the directions say you should.
• Avoid breathing fumes. Use products only in well-ventilated areas.
• Never mix products unless directed to do so by the label directions. This can cause explosive or poisonous chemical reactions. Mixing chlorine bleach with ammonia or with acid toilet bowl or drain cleaners, for example, can result in the development of toxic fumes.
• Keep hazardous products away from your mouth. Never eat, drink or smoke when using hazardous products.
• Keep products in their original container. Never transfer a hazardous product to a food container where it can be mistaken for food.
• Keep containers closed when not in use.
• Use protective clothing (gloves, goggles) whenever it is recommended on the label.

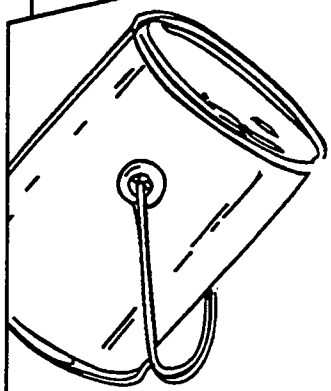


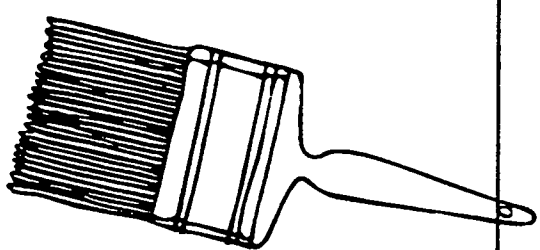
Reuse/Recycling
Reusing and recycling materials that can be used again helps to reduce the threat hazardous products pose to

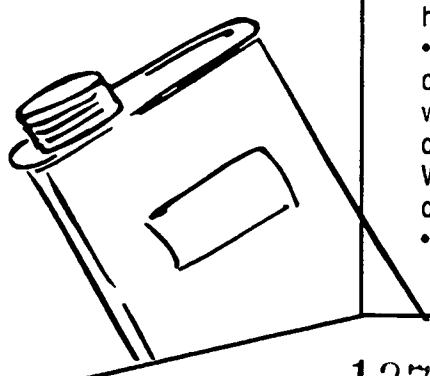




Guide to Hazardous Products in your Home







public health and the environment.

Reuse and Recycling Suggestions:

- Give away your unwanted portions of products such as paint and household cleaners to friends, neighbors or community groups who can use them.
- Recycle your used motor oil by returning it with your receipt to the place where it was purchased. If you no longer have a receipt, find out if your community has a waste oil colleciton site available.
- Consult your telephone directory for the nearest battery recycler in your area.

Safe Disposal

Finally, dispose of household hazardous products safely. For years, people have haphazardly disposed of household hazardous waste by pouring it down the drain, tossing it in the trash or burying it in the backyard. This continuous release of small amounts of hazardous waste can eventually create a big problem.

Impacts of Improper Disposal:

- Household hazardous waste that is poured or washed down storm drains can go directly into local streams, rivers or Boston Harbor, where it can cause both immediate and long-term damage to water quality and aquatic life.
- Household hazardous waste that is poured down the sink or toilet eventually reaches either the Deer Island or Nut Island Sewage Treatment Plant. Many of the toxic chemicals and heavy metals in household hazardous waste cannot be fully broken down or removed by sewage treatment. As a result, some pollutants flow through the Deer Island and Nut Island Treatment Plants and into Boston Harbor, where they can accumulate in the sediments that are the feeding ground for the harbor's marine life.
- Household chemicals carelessly poured down the drain or tossed in the trash can injure workers who operate the wastewater collection and treatment system or who collect or process solid waste refuse from homes. Workers can be exposed to dangerous chemicals, causing immediate injuries or long-term problems.
- Once the toxins in household hazardous waste are

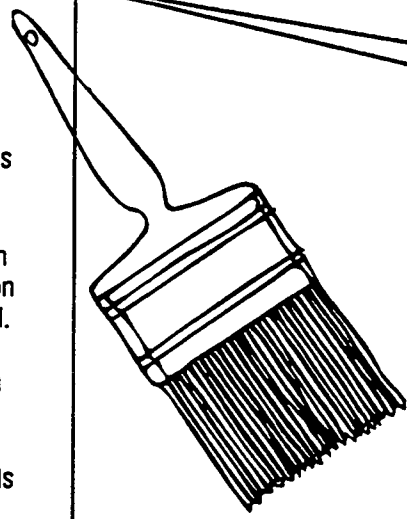
released to the environment, they can eventually work their way up the food chain, becoming more and more concentrated each step of the way. This process, know as "bio-magnification", causes the highest concentrations of toxins to occur in animals near the top of the food chain.

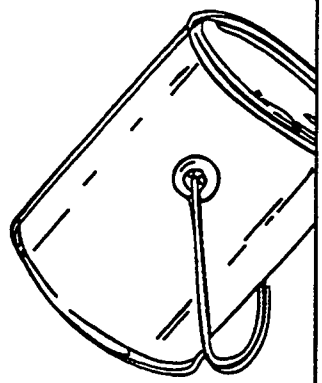
- Household hazardous waste that is thrown in the trash may be eventually released to the air through incineration or may contaminate groundwater if improperly landfilled.
- Household hazardous waste that is poured on the ground can poison plants and animals and filter through the soil into groundwater.

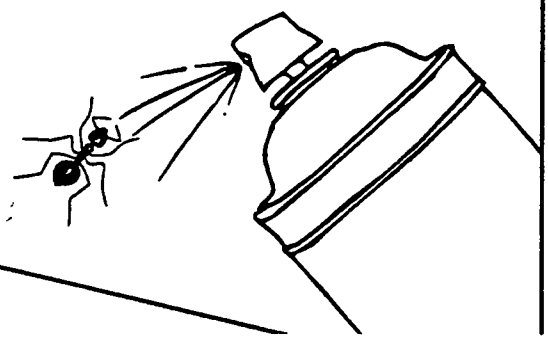
For example, household pets have died after drinking from puddles of anti-freeze, which is attractive to animals because of its sweet taste.

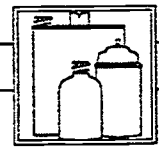
Proper Disposal Suggestions:

- Read the product label to see if there are any recommendations for proper disposal.
- Find out if your community is planning to hold a household hazardous waste collection day. If such an event is scheduled, safely package and transport your waste to the collection location.
- If an event is not scheduled for this year, store your waste as safely as possible and encourage your community to sponsor a household hazardous waste collection day in the near future.
- Contact state agencies for more information about current disposal options or recommendations for specific products. Two such agencies are: **Commonwealth of Massachusetts**, Executive Office of Environmental Affairs, Office of Technical Assistance, 100 Cambridge Street, Boston, MA 02108, (617) 727-3260; and the **Massachusetts Water Resources Authority**, Toxic Reduction and Control Department, Sewerage Division, Charlestown Navy Yard, 100 First Avenue, Boston, MA 02129, (617) 242-6000.









THE DISPOSAL DILEMMA

DID YOU KNOW.... ?

- 90 percent of all American households use pesticides in their homes, gardens or yards.

- At 400 million gallons per year, Americans improperly dispose of 35 times more used motor oil than was spilled in the entire Exxon Valdez oil spill. At least half that amount is thrown out by do-it-yourself oil changers.

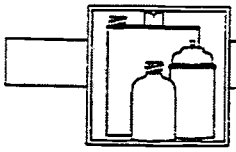
- The average American household contains approximately 80 pounds of household hazardous waste stored in closets, basements, garages, etc.

Exercise
Use the attached Product Tables and Decision Matrices to help you determine the risks and benefits of possible solutions to the problems described below.

Problem 1
While helping your grandparents clean their garage, you find several containers of **used motor oil**, **used antifreeze** and **rusty gasoline**. What should you do with them?

Problem 2
You and your sister decide to paint your bedroom with a brightly colored **enamel paint**. When you're done, you have a half-gallon of left-over paint, a jar of **paint-contaminated solvent** that you used to clean the brushes, and some left-over **paint stripper**. You consider saving the left-over paint and paint stripper, but doubt that you or your family will have much use for them anytime soon. If you don't want to save them, then you must figure out what to do with them instead.

Problem 3
Your kitten just got sick from licking her feet clean after walking across your lawn that had been recently treated with **weed-killer**. Your parents realize that the pesticide is probably not very good for your little brother, either, who spends a lot of time crawling around the grass. Your parents only recently purchased the 50 pound bag of ***2,4-D*** (powder pesticide) and still have half of it left. What should they do with it?



What are Household Hazardous Products and Household Hazardous Waste?

DECISION MATRIX

Group # _____

Problem 1

Common Disposal Methods	Benefits/Advantages	Risks/Disadvantages
Pour down storm drain.		
Throw in trash can.		
Pour out onto the grass or driveway.		
Bury in ground.		

Other Options

Return your used motor oil, with a receipt, to the place where it was purchased (Mass. law).

Use less automotive products (drive less).

Lobby for **all** gasoline stations to be required to take waste products from cars, for free.

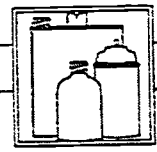
Use the gasoline to start the barbecue.

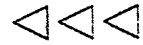
Lobby to have your community establish a household hazardous waste collection center.

Bring your wastes to a licensed hazardous waste handler who will properly dispose of or recycle your wastes for a fee.

Final Decision:

Comments/Questions:





DECISION MATRIX

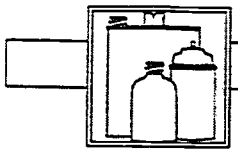
Group # _____

Problem 2

Common Disposal Methods	Benefits/Advantages	Risks/Disadvantages
Pour down storm drain.		
Throw in trash can.		
Bury in ground.		
Pour down sink.		
Other Options Take to a licensed hazardous waste handler who will properly recycle it for a fee.		
Give left-over paint to a local community or theater group.		
Require manufacturer to provide directions for disposal.		
Require stores to provide disposal places.		
Reuse brush cleaning solvent by letting it sit in a closed jar until paint particles settle out. Strain off the usable solvent and wrap remaining paint sludge in newspaper and discard in trash.		
Next time, use water-based (latex) paint instead.		

Final Decision:

Comments/Questions:



What are Household Hazardous Products and Household Hazardous Waste?

DECISION MATRIX **Group # _____**

Problem 2

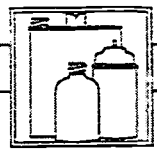
Common Disposal Methods	Benefits/Advantages	Risks/Disadvantages
Pour down storm drain.		
Throw in trash can.		
Bury in ground.		
Pour down sink.		
Pour it in the backyard where your brother and kitten aren't likley to go.		

Other Options

Take to Health Department.		
Take to a licensed hazardous waste handler who will properly recycle it for a fee.		
Share excess with a neighbor.		
Require manufacturer to provide directions for disposal.		
Require stores that sell pesticides to provide a place for disposal.		
Hand-pick weeds, instead of using pesticides.		
Lobby to ban the sale or use of pesticides in your town.		

Final Decision:

Comments/Questions:



What are Household Hazardous Products and Household Hazardous Waste?

Product Table: Automotive Products

Substance	Environmental Fate	Biological Effects	Disposal Issues
Motor Oil Oil is a **hydrocarbon.** A variety of additives may be used, such as: **heavy metals, aromatic** and **halogenated hydrocarbons, detergents, dyes, TCP (tricresyl phosphate).** Used motor oil contains contaminants from engine wear and combustion, such as: **lead, cadmium** and **mercury.**	Oil is degraded in about 2 months by microorganisms. Insoluble in water. Floats in sheets on water surface. **Cadmium** and **lead** are very persistent. **Cadmium** (and to some extent, **lead**) can be taken up by plants and transported to leaves and fruit. **Cadmium** bioconcentrates in marine organisms. **Lead** bioaccumulates in algae.	Oil is toxic to mammals when ingested and possibly through dermal exposure. Toxicity varies according to the geographical origin of the crude oil. Oil destroys the insulating properties of fur and feathers, causing oiled fur-bearers or water fowl to die of cold. LD_{50} (rats) = 4680mg/kg Toxic to aquatic organisms at 1-10ppm. In mammals, **lead** can cause kidney damage and neurological disorders. It is a teratogen and suspected mutagen. **Lead** is acutely toxic to aquatic invertebrates. **Cadmium** is acutely toxic to fish at concentrations as low as 1ppb. It is a dangerous cumulative poison for mammals. In humans, **mercury** can cause nervous system and kidney disorders.	Large volumes are disposed of. In Massachusetts, 3.5 million gallons/year of "do-it-yourself" used motor oil are **not** recycled. Dumping into any waterway or surface water is illegal (Clean Water Act). MWRA Sewer Use regulations prohibit the discharge of motor oil into the sewer. The major problem is with oil entering rivers, lakes or oceans. Cans have the following statement on the label, "Don't pollute, conserve resources, return used oil to collection centers."

Product Table:	Automotive Products (cont.)		
Substance	**Environmental Fate**	**Biological Effects**	**Disposal Issues**
Antifreeze Main ingredient: **Ethylene Glycol** Sometimes small amounts of: **borates** **phosphates** **silicates** **Used antifreeze** is contaminated with **heavy metals** such as **lead, cadmium** and **zinc.**	**Ethylene glycol** is water soluble. It is fairly quickly degraded by micro-organisms. **For heavy metals see Motor Oil .**	**Ethylene glycol** is sweet tasting and may attract pets and other animals. It is acutely toxic to mammals when ingested in large quantities. In humans, it is metabolized into oxalic acid and/or excreted unchanged in the urine. It can have chronic kidney effects. LC_{50} for aquatic organisms = 100-1000 ppm. **For heavy metals see Motor Oil .**	MWRA Sewer Use Regulations forbid the discharge of waste such as **used antifreeze** which exceeds the Discharge Limits for specific heavy metals. Use on fence posts as a preservative not recommended as it can dissolve other preservatives and cause them to leach into the soil.
Gasoline Gas is a hydrocarbon. Additives include: **tetraethyl lead** **ethylene dichloride/dibromide** **amines** **alkylated phenols** **detergents** **dyes**	Gasoline is highly volatile and flammable. **For lead, see Motor Oil.**	Gasoline often contains **benzene,** a known carcinogen and also **toluene** and **xylene** (see solvents). **For lead, see Motor Oil. Tetraethyl lead** is extremely toxic to mammals. Oral LD_{50} (rats) = 17 mg/kg. **Ethylene dichloride** and **dibromide** cause liver damage. Certain **alkylated phenols** cause burns and severe disorders.	The main problem with disposal of gasoline is its extreme flammability. MWRA Sewer Use Regulations prohibit the discharge of gasoline to the sewer system. Uncontaminated gasoline can be used. Contaminated gasoline should be disposed of with great care.

What are Household Hazardous Products and Household Hazardous Waste?

Product Table: Paint Products

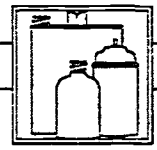
Oil-Based Paints contain:

1) **Resins** - substances which produce a film.
2) **Solvents** - volatile liquids which allow the paint to be applied in liquid form and then evaporate, which is what happens when the paint is drying.
3) **Pigments** and **colors**.

Thinners and **Paint Strippers** are almost 100% solvents.

Substance	Environmental Fate	Biological Effects	Disposal Issues
Resins **Acrylic Resin** This is a general name for **polymers** (a long chain of relatively simple molecules repeated over and over) of **acrylic acid, methacrylic acid** and its **esters** or **acrylonotrile**. **Pigments & Colors** Many older paints based on heavy metals such as **lead, cadmium, chronium** and **mercury**. These are still in hobby paints, but most household paint is now made with less toxic metals. **Mercury** has typically been added to 1/4 to 1/3 of latex paint, but is now banned for use in interior paint.		May lead to allergic responses from skin contact or inhalation. **For heavy metals see Motor Oil .**	General Disposal Issues: Liquids should not be put into the trash. Flammability is a major concern in relation to storage and disposal. MWRA Sewer Use Regulations prohibit the discharge of any liquids, solids or gases which may be sufficient, either alone or with other substances, to cause fire or explosion.

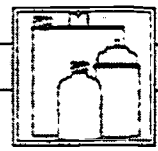
Product Table: Paint Products (cont.)			
Substance	**Environmental Fate**	**Biological Effects**	**Disposal Issues**
Solvents		General Effects: Main exposure from inhalation due to volatility. All solvents are toxic to varying degrees. All can cause skin disease, irritation to eye, nose or throat and nervous system disorders. Many can cause damage to liver and kidney. Some solvents are carcinogens and some may cause damage to the reproductive system.	
Propylene Glycol Glycol ethers & esters	Water soluble. Relatively low volatility.	Generally low acute toxicity to mammals.	
Methanol	Soluble in water. Volatile.	In primates, can cause blindness.	
Toluene	Highly water soluble. Volatile. Can re-enter hydrosphere in rain. Subject to photochemical degradation. Residues found in fish caught in vicinity of petrochemical industries.	Routes of entry, inhalation, ingestion; less so from dermal exposure. Irritant to nose and throat. Possibly causes chronic liver and kidney damage.	



Product Table: Pesticides

Substance	Environmental Fate	Biological Effects	Disposal Issues
2,4-D (2,4-dichloro-phenoxyacetic acid)	Degraded by oxidation and microbial activity. Persistence less than 3 months in damp soils, can be up to 18 months in dry soils. Solubility - moderate Volatility - high Mobility - high	Routes of entry dermal, GI and respiratory. Excreted relatively rapidly and unchanged. Causes some irritation of mucous membranes and also some nerological effects. Acutely toxic to mammals: LD_{50} (rats) = 400mg/kg. Relatively harmless to bees. Acutely toxic to fish at low concentrations. Controversial evidence of mutagenicity, teratogenicity and carcinogenicity.	General Disposal Issues Relevant to All Pesticides Yard and garden pesticides can enter the environment through use, via leaching into the soil, evaporation into the air and in run-off with rainwater into the storm sewers or waterways. Pesticides that are persistent and/or bioaccumulate are of special concern environmentally. Many pesticides have some evidence of chronic health effects, although data are often contradictory. Each year, an estimated 67 million pounds of active pesticide ingredients are applied to American lawns. No specific information on use in the MWRA service area.

Lesson 8



Reading Product Labels

Purpose:

To get students in the habit of reading hazardous product labels carefully.

Lesson in brief

Students learn to interpret the information that manufacturers are required to include on hazardous product labels.

Key words and concepts

Learning to read the small print on hazardous product labels will help you to buy the least hazardous product possible, as well as to use hazardous products as safely as possible.

Active Ingredients Inert Ingredients

Materials

- "Reading Product Labels - Part A."
- "Reading Product Labels - Part B."
- 4-5 examples of household hazardous products (examples could include furniture polish, drain cleaner, nail polish remover, varnish, spot remover, etc.).

Time required

One class period.

Procedure

1. Set up a display of common household hazardous products in an accessible area of the classroom.

2. Distribute "Reading Product Labels - Part A," and discuss questions/ answers with students.

3. Distribute "Reading Product Labels - Part B." Ask students to form small groups. Ask each group to answer the questions on Part B for at least one of the household hazardous products that you have on display.

Background information

There are two federal acts which govern the labeling of hazardous products:

The Federal Hazardous Substances Act regulates the labeling of hazardous products other than pesticides.

The Federal Insecticide, Fungicide and Rodenticide Act regulates the labeling of pesticide products.

1. According to the *Hazardous Substances Act*, the labels of non-pesticide products demonstrating an *acute* effect due to the result of a hazardous ingredient must include the following information:

- Signal words such as "Danger," "Warning," or "Caution" and the statement "Keep Out of Reach of Children."

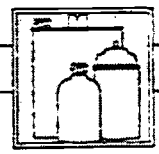
"Danger" means that the product is extremely flammable, corrosive or highly toxic.

"Warning" or ***"Caution"*** appear on all other hazardous substances.

- A description of the hazard involved in using the product (i.e. "irritant," "flammable," "vapor harmful").
- A statement of how to avoid the hazard (i.e.. "use in well-ventilated room").
- A list of the common and /or chemical names of the hazardous ingredients.
- First aid instructions.
- Name and address of the manufacturer, distributor or packer.
- Amount of contents and instructions for safe handling and use.

Despite these requirements, non-pesticide product labels serve more as a product advertisement than a source of information about product safety. It is usually necessary to read all of the fine print on the label to obtain the information you need to protect yourself from any dangers presented by working with a hazardous product. A hazardous product should not be used unless adequate instructions on how to use the product safely are available.

To better your chance of buying and using the least hazardous products possible, choose products with a "Caution" label over those whose labels say "Warning" or "Danger." Better still, look for products with no warnings at all. Remember that the labeling requirements of the *Hazardous Substances Act*, including the signal words "Caution," "Warning," "Danger" only address acute toxicity. They do not take into consideration the chronic (long-term) health effects of a product or the environmental hazards associated with it.



2. The labeling requirements for pesticides are much more complete and detailed than those for non-pesticide products. This is because pesticides are often more toxic than other hazardous products used around the home. The directions for use and warning or precautionary statements on pesticide labels contain detailed information to which the user of the product should always read and pay attention. Careful reading of a pesticide label not only increases the chance that the user will apply the product as safely as possible, but also that the user will not violate federal law by using the product in a manner which is inconsistent with its labeling.

Sample discussion questions

1. What are the largest and most visible words on the product label depicted on "Reading Product Labels - Part A?" Are they the product use and safety instructions or the brand name and effectiveness of the product?

2. What are the differences in the content of the various product labels that are on display in the classroom? Do some contain more detailed safety instructions than others? Do any of them fail to list the ingredients? Do all of them list the quantities for proper use?

3. Why is it important to know what ingredients are contained in a product? **(So that you can adequately protect yourself from any dangers presented by working with that product.)**

4. What should you do if a product label does not provide a listing of ingredients or adequate instructions on how to safely use the product? **(You should consider using another product instead.)**

This lesson was adapted from *Sleuth: Educational Activities on the Disposal of Household Hazardous Waste*. Metro Toxicant Report No. 1D, Aug. 1982. Water Quality Division, Municipality of Metropolitan Seattle.

Answer Sheet

Reading Product Labels Worksheet - Part A

Learning to read the small print on hazardous product labels will help you to (1) buy the least hazardous product possible and (2) use hazardous products as safely as possible.

Directions:

Use the product label pictured on following page to answer the questions below.

1. What is the brand name of this product? ***Whiz Clean!***

2. What is this product used for? ***To remove spots from carpets and upholstery***

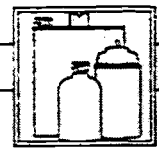
3. How does this product work? ***It dissolves the substance making up the spot and removes it from the fabric.***

4. What are the active ingredients in this product? What percentage of the total product and equivalent weight/volume is each of the active ingredients?

Active Ingredient	% of total product	Weight/Volume of ingredient
Perchloroethylene	***45.25%***	***.4525 X 14 oz. = 6.335 oz.***
Trichloroethane	***33.50%***	***.3350 X 14 oz. = 4.69 oz.***

Note: The active ingredients are the chemicals which actually perform the intended function of the product. For example, in a pesticide, the active ingredient is the chemical that actually kills pests. The active ingredient may only be a small percentage of the total content. The rest of the product (inert ingredients) is made up largely of a vehicle -- a substance that carries the active ingredients in a form that makes them easy to apply or use. Such things as perfume or coloring agents are also considered inert ingredients.

Although most non-pesticide labels list only active ingredients, it is important to remember that "inert" only means inactive in relation to the intended function of the product. "Inert" does not necessarily mean harmless to humans or the environment.



5. How should this product be used or applied? *Remove excess substance from fresh spots and let spot dry. Shake can until ball moves freely. Hold can upright 6 to 8 inches from spot. Spray 1 - 2 seconds. Let dry completely and brush away power.*

6. What, if any, are the application precautions given? *Blot spots containing sugar, flour or milk with a damp cloth before applying product. Product should be tested on inside seam to make sure fabric is colorfast. Spray enough "Whiz Clean" to cover spot, but do not saturate. Do not treat garment while wearing it.*

7. How much is recommended per application? *Does not say. Only says to spray for 1 - 2 seconds and not to saturate.*

8. What effects on human health or the environment, which could result from the use of this product, does the label warn you about? *Hazardous to humans if sprayed in eyes or on skin. Hazardous to human health if inhaled for a prolonged period. Deliberately concentrating and inhaling contents may be harmful or fatal. No warnings about potential environmental impacts.*

9. What first aid instructions, if any, are given? *Flush thoroughly with water if contact occurs in eyes or on skin.*

10. What suggestions, if any, are given for disposal of the container? *None.*

11. Do you know of any alternatives to use instead of this product?
Examples: Club soda - fruit juice, catsup, gravy, red wine
Baking soda - animal urine
Immediate cold water - blood

Adapted from: ***Sleuth: Educational Activities on the Disposal of Household Hazardous Waste.*** **Metro Toxicant Program Report No. 1D, Aug. 1982. Water Quality Division, Municipality of Metropolitan Seattle.**

WHIZ CLEAN

Removes spots fast and easy!

WHIZ CLEAN is formulated for dry-cleanable fabrics, polyester, acrylic, nylon and wool blends. Do not use WHIZ CLEAN on suede, rubber, plastic, latex acetate, velvet or varnished surfaces.

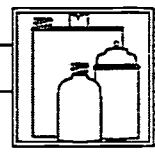
DIRECTIONS

1. Remove excess from fresh spots and, if spot contains water, let dry before using WHIZ CLEAN. Spots containing sugar, flour or milk may retain WHIZ CLEAN powder and should be blotted with a damp cloth first.
2. Make sure dyed fabrics are colorfast by testing WHIZ CLEAN on an inside seam or other hidden place.
3. Shake can until ball moves freely; hold can upright (do not invert) 6 to 8 inches from spot. Depress button fully and spray at least 1 to 2 seconds. Spray enough WHIZ CLEAN to cover spot but do not saturate.
4. Let WHIZ CLEAN dry completely. Brush away powder. Some spots may need a second application.

CAUTIONS: Do not treat garment while wearing. Do not spray in eyes or on skin. If contact occurs, flush thoroughly with water. Avoid prolonged breathing of vapor. Do not puncture. Do not throw in fire as container will burst. Do not use near fire or flame. Intentional misuse by deliberately concentrating and inhaling contents can be harmful or fatal. KEEP AWAY FROM CHILDREN.

ACTIVE INGREDIENTS

Perchloroethylene	45.25%
Trichloroethane	33.50%



Reading Product Labels Worksheet - Part A

Learning to read the small print on hazardous product labels will help you to (1) buy the least hazardous product possible and (2) use hazardous products as safely as possible.

Directions:

Use the product label pictured on following page to answer the questions below.

1. What is the brand name of this product?_____

2. What is this product used for?_____

_____

_____

3. How does this product work?_____

_____

_____

4. What are the active ingredients in this product? What percentage of the total product and equivalent weight/volume is each of the active ingredients?

Active Ingredient	% of total product	Weight/Volume of ingredient
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Note: The active ingredients are the chemicals which actually perform the intended function of the product. For example, in a pesticide, the active ingredient is the chemical that actually kills pests. The active ingredient may only be a small percentage of the total content. The rest of the product (inert ingredients) is made up largely of a vehicle -- a substance that carries the active ingredients in a form that makes them easy to apply or use. Such things as perfume or coloring agents are also considered inert ingredients.

Although most non-pesticide labels list only active ingredients, it is important to remember that "inert" only means inactive in relation to the intended function of the product. "Inert" does not necessarily mean harmless to humans or the environment.

5. How should this product be used or applied?_____

6. What, if any, are the application precautions given?_____

7. How much is recommended per application?_____

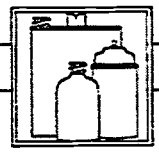
8. What effects on human health or the environment, which could result from the use of this product, does the label warn you about?_____

9. What first aid instructions, if any, are given? _____

10. What suggestions, if any, are given for disposal of the container? _____

11. Do you know of any alternatives to use instead of this product?_____

Adapted from: *Sleuth: Educational Activities on the Disposal of Household Hazardous Waste*. Metro Toxicant Program Report No. 1D, Aug. 1982. Water Quality Division, Municipality of Metropolitan Seattle.



Reading Product Labels

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ACTIVE INGREDIENTS	
Perchloroethylene	45.25%
Trichloroethane	33.50%

WHIZ CLEAN

SPOT REMOVER
For Carpets and Upholstery

Removes Spots Fast & Easy!

Caution: Eye Irritant, Vapor Harmful
Contents Under Pressure

Read cautions on back panel carefully

NET WT. 14 OZ

Reading Product Labels Worksheet - Part B

Directions:

Answer the following questions using the label from a "real" product that your teacher brought in from home.

1. What is the brand name of this product?_____

2. What is this product used for?_____

3. How does this product work?_____

4. What are the active ingredients in this product? What percentage of the total product and equivalent weight/volume is each of the active ingredients?

Active Ingredient	% of total product	Weight/Volume of ingredient

5. How should this product be used or applied?_____

6. What, if any, are the application precautions given?_____

7. How much is recommended per application?_____

8. What effects on human health or the environment which could result from the use of this product, does the label warn you about?_____

9. What first aid instruction, if any, are given? _____

10. What suggestions, if any, are given for disposal of the container? _____

11. Do you know of any alternatives to use instead of this product?_____

Adapted from: ***Sleuth: Educational Activities on the Disposal of Household Hazardous Waste.*** **Metro Toxicant Program Report No. 1D, Aug. 1982. Water Quality Division, Municipality of Metropolitan Seattle.**

Lesson 9

Lesson 9 Home Hazardous Product Survey

Purpose:

To increase students' awareness of their personal impact on the environment, and to show them that their home is one place where they really can make a difference.

Lesson in brief

Students and their families compile an inventory of hazardous products in their homes. Students compare their results in class to estimate the average home hazardous product inventory and the total amount of such substances in their community.

Key words and concepts

Few people realize just how many hazardous products are commonly used in their home.

Absorption	Corrosive	Ingestion	Toxic
Acute Effects	Explosive	Inhalation	
Chronic Effects	Flammable	Solvent	

Materials

- "Parental/Guardian Permission Form."
- "Protecting Yourself From Household Hazardous Products."
- "Home Hazardous Product Survey Sheet."
- "Class Data Sheet."
- Calculator

Time required

Two class periods.

Background information

When using or handling a product which contains potentially harmful ingredients, there are several precautions that we should take to protect ourselves from injury. "Protecting Yourself From Household Hazardous Products" gives an overview of these precautions.

Procedure

Prior to Day 1:

1. Use "Parent/Guardian Permission Form" to inform parents/guardians about the Survey, and to obtain their permission. Attach a copy of the "Home Hazardous Product Survey" for the parent/guardian to review.

2. Call your town or city hall to determine the population of your community.

Day 1:

1. Distribute "Protecting Yourself From Household Hazardous Products" and discuss.

2. Distribute "Home Hazardous Product Survey."

Day 2:

1. Distribute "Class Data Sheet."

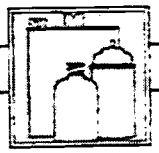
2. Analyze the results of the Survey:

   a. Write the major household hazardous product categories on the blackboard (Paints and Solvents, Household Cleaners, Pesticides, Automotive Products, Other).

   b. Enter students' totals for each category on the blackboard. Total and average the numbers in each category.

   c. Estimate the total number of households in your community: An average household contains 2.65 people. To estimate the total number of households in your community, divide the total population by 2.65.

   d. Use this information to work out the problems on the "Class Data Sheet."



Discussion questions

1. Based on the students' surveys, what is the largest category of household hazardous products? What is the smallest?

2. Have each student compare his/her data from home with the class averages. Is his/her figure above or below?

3. Do your students think the totals estimated in class are an accurate representation of their community? Of every community in the Boston area? Of every community in the United States?

4. Would people in different areas of a community, group of communities or country use different kinds or amounts of household hazardous products?

   For example, would people who live in an apartment tend to use fewer pesticide products than people who live in a house with a yard? Would people who live in a city tend to drive fewer miles and, therefore, use less motor oil than people who live in more rural areas? Would people who live in the Northeast, where cold winters require heavy sweaters, coats, etc. tend to use more mothballs than people who live in California?

5. In what part of students' homes were the greatest number of products with labels containing the words "Danger" or "Poison" found?

6. What are some of the problems with the method used to collect this data?

   For example, the volumes of the products inventoried were not recorded; there may be many different ingredients in products of the same type which are made by different manufacturers; product age, and therefore hazard, may vary; the condition of the product containers was not noted; all containers were counted equally; and all products were considered equally hazardous.

7. Although the quantity of hazardous products used by individual householders is relatively small, a community as a whole can contribute a significant amount of household hazardous waste.

   Based on the estimated number of household hazardous products in your community (refer to your Class Data Sheet), estimate the volume of hazardous products used or stored in your community.

Assume that each container holds 8 ounces and that each container is only one quarter full. Since one quarter of 8 ounces equals 2 ounces, the estimated volume of hazardous products in your community is determined by multiplying the number of hazardous products by 2 ounces.

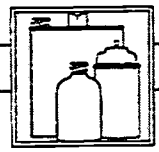
This exercise is intended to make students comfortable with making assumptions and using them to estimate or evaluate a situation. Discuss these assumptions with your students (an 8 ounce container and 1/4 full). Are they realistic?

Assume further that 5% of this volume of household hazardous products is thrown away per month. Estimate the amount in pounds (1 pound = 16 ounces) of household hazardous waste disposed per month and per year in your community. Is 5% a realistic assumption?

8. What are the consequences of household hazardous wastes that are disposed of improperly? How would your students encourage householders in your community to properly dispose of their household hazardous waste or to reduce their use of hazardous products? What types of outlets are available for proper household hazardous waste disposal?

Refer to "What are Household Hazardous Products and Household Hazardous Waste" for some answers to these questions.

Material adapted from *The Missouri Household Hazardous Waste Project*, 901 S. National Ave., Box 108, Springfield, MO 65804.



Home Hazardous Product Survey Parental/Guardian Permission Form

Dear Parent or Guardian,

Just as many of us would like to be more informed about the industrial chemicals which are used, stored and disposed in our communities, it is important that we become more informed about the chemical products found right in our own homes. As consumers, we are often given little information on the potential health and environmental effects associated with the chemicals in "everyday" household products. To use and dispose of them safely, we need to learn more about the potential dangers (both immediate and long-term) associated with household products.

During the week(s) of _____, our class will be working to develop a greater awareness of the household hazardous products we commonly buy and use. We will begin by identifying some everyday products and discussing their potential effects on our health and our environment. We will identify ways to reduce these effects, including proper use and disposal and substitution of household hazardous products with readily available, safer alternatives.

One of the activities which may be included in this unit is a Home Hazardous Product Survey, which asks students to take an inventory of hazardous products commonly used in their own homes. To insure that students do not handle any products in ways that could potentially hurt them, the Home Hazardous Product Survey Activity will not be assigned to any students whose parents or guardians are unable to assist them. The survey should take a little over an hour to complete.

Please indicate below whether or not you are able to assist your child in conducting the Home Hazardous Product Survey and ask your child to return this form to me.

Sincerely,

Teacher

Student's name:_____

____ Yes, I am able to assist my child in conducting the Home Hazardous Product Survey.

____ No, I am not able to assist my child in conducting the Home Hazardous Product Survey.

Protecting Yourself From Household Hazardous Products

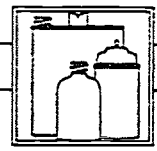
When using any product containing potentially harmful ingredients, there are several precautions you should take to protect yourself from injury.

To prevent hazardous substances from entering your body through INGESTION:

- Never eat, drink or smoke while using a hazardous product.
- When you have finished working with a hazardous product, remove all contaminated clothing and wash all exposed body parts before putting anything in your mouth.
- Never store hazardous products in close proximity to food items.
- Keep hazardous products in their original containers; never store hazardous products in food or beverage containers (i.e., coffee cans, juice bottles, milk jugs).

To prevent hazardous substances from entering your body through INHALATION:

- Use hazardous products only in well-ventilated areas. If possible, work outside.
- Take breaks to get "fresh air."
- If working inside, use a fan to direct air away from the work area through an open window to the outdoors.
- Avoid using aerosols as much as possible (aerosolized particles can be inhaled deeply into the lungs and quickly absorbed into the bloodstream).
- Do not leave containers opened, especially those whose contents can evaporate quickly and create harmful airborne fumes.
- Never mix products unless specifically instructed to do so on the product label (mixing products can produce toxic fumes).



To prevent hazardous substances from entering your body through ABSORPTION:

- Avoid wearing soft contact lenses when using hazardous products (soft contacts can absorb hazardous vapors and hold them close to your eye where they may damage your eye or be absorbed into the blood stream).
- Wear proper safety equipment, including gloves and safety goggles, when ever working with products that can be splashed into your eyes or absorbed through your skin.
- Wear proper clothing to protect as much of your body as possible from contact with toxic or corrosive chemicals.

To prevent hazardous substances from EXPLODING or CATCHING FIRE:

- Store all flammable or explosive products away from any sources of heat, flame or sparks.
- Never mix products unless specifically instructed to do so on the product label (mixing products can produce explosive reactions).
- Store solvent-stained rags in covered containers.
- Install smoke detectors and fire extinguishers in areas where hazardous products are used or stored.

Name_____

Home Hazardous Product Survey Sheet

Directions:

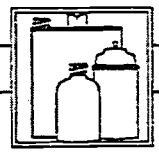
(1) Read the student handout "Protecting Yourself From Household Hazardous Products."

(2) Check with a parent or guardian before starting the survey, to make sure that he or she is able to assist you.

(3) Look through your home to find these products that are likely to be stored in the areas listed below. Read the labels to determine if the product you have is potentially hazardous (look for the signal words "Danger," "Warning," "Caution"). If it is, estimate the number of containers you have and write this number in the space after the product. Try to estimate how long the product has been stored in your home. Note whether any unused portion of the product is more likely to be used up or thrown away.

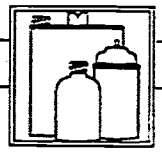
Be very careful handling these products: Do not spill the contents. Wash your hands thoroughly after you have handled any containers that may be leaking and when you have finished with the survey.

	No. of containers	How long stored (less or more than 1 yr.)	Likely to be used up
Workshop/Basement			
Paints and Solvents			
Paint - oil based			
Paint - latex			
Paint - auto			
Paint - model			
Varnish			
Paint Thinner			
Furniture Stripper			
Turpentine			
Primer			



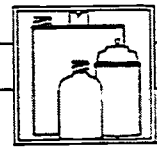
Home Hazardous Product Survey

	No. of containers	How long stored (less or more than 1 yr.)	Likely to be used up
Other			
Flashlight Batteries	_____	_____	_____
Button Batteries	_____	_____	_____
Photo Chemicals	_____	_____	_____
Mothballs	_____	_____	_____
Artists' Paints	_____	_____	_____
Lighter Fluid	_____	_____	_____
Other	_____	_____	_____
Total number of products in Workshop/Basement	_____		
Kitchen			
Cleaners			
Drain Cleaner	_____	_____	_____
Oven Cleaner	_____	_____	_____
Floor Cleaner	_____	_____	_____
Window Cleaner	_____	_____	_____
Ammonia	_____	_____	_____
Scouring Powder	_____	_____	_____
Paints and Solvents			
Furniture Polish	_____	_____	_____
Spot Remover	_____	_____	_____
Metal Polish	_____	_____	_____
Shoe Polish	_____	_____	_____
Other			
Air Fresheners	_____	_____	_____
Aerosol Sprays	_____	_____	_____
Flashlight Batteries	_____	_____	_____
Button Batteries	_____	_____	_____
Total number of products in Kitchen	_____		



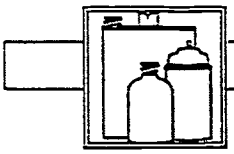
Home Hazardous Product Survey

	No. of containers	How long stored (less or more than 1 yr.)	Likely to be used up
Bathroom			
Paints and Solvents			
Nail Polish			
Nail Polish Remover			
Cleaners			
Tub & Tile Cleaner			
Toilet Bowl Cleaner			
Disinfectants			
Other			
Air Fresheners			
Aerosol Sprays			
Total number of products in Bathroom			
Garage			
Pesticides			
Weed Killers			
Insecticides			
Fertilizers (w/pesticide)			
Bug Repellent			
Rat Poison			
Flea Spray/Collars			
Automotive Products			
Car Wax			
Motor Oil			
Gasoline			
Kerosene			
Antifreeze			
Windshield Solution			



Home Hazardous Product Survey

	No. of containers	How long stored (less or more than 1 yr.)	Likely to be used up
Paints and Solvents			
Paint - oil based	_____	_____	_____
Paint - latex	_____	_____	_____
Paint - auto	_____	_____	_____
Paint - model	_____	_____	_____
Varnish	_____	_____	_____
Paint Thinner	_____	_____	_____
Furniture Stripper	_____	_____	_____
Glue	_____	_____	_____
Turpentine	_____	_____	_____
Other			
Pool Chemicals	_____	_____	_____
Mothballs	_____	_____	_____
Total Number of products in Garage	_____		
Total number of Household Hazardous Products	_____		



Name_____

Class Data Sheet

Directions:

Record the number of households surveyed in your class. Fill in the class totals of household hazardous products for each category. Calculate the average number of products per household for each category and the total. Calculate the answers to the other questions using the formulas given.

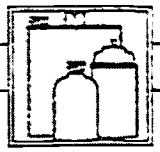
Number of Households Surveyed in Your Class _____ = b

Category	Class Total		Average Number of Products Per Household
Workshop/Basement	_____	/b=	_____
Kitchen	_____	/b=	_____
Bathroom	_____	/b=	_____
Garage	_____	/b=	_____
TOTAL	_____	/b=	_____(c)

Population of your community _____(d)
Estimated number of households in your community _____(d/2.65 =e)
Estimated number of household hazardous products in your community _____(c x e)

Adapted from *The Missouri Household Waste Project*, **901 South National Ave, Box 108, Springfield, Missouri 65804.**

LESSON 10



Lesson 10 Safer Alternatives to Hazardous Household Cleaners

Purpose:

To make students aware of some safer alternative products and recipes that they may use in the place of modern household cleaners.

Lesson in brief

Students examine advertising for modern household cleaners, then learn and experiment with some safer alternatives.

Key words and concepts

Many modern household cleaners contain chemical ingredients which can be hazardous to the environment and to human health. Although they may require a little more time and effort to get the job done, many alternatives to hazardous household cleaners are available and effective.

Alternative Hazardous

Materials

- "Safer Alternatives for Hazardous Household Cleaners."
- "Alternatives Assignment Sheet."
- Magazines, newspapers, etc., containing advertisements for modern house hold cleaners.
- Large sheet of paper, glue, scissors.
- Examples of safer alternative cleaning products (vinegar, baking soda, vegetable oil, lemon juice, etc.).
- Examples of hazardous products that students frequently use (turpentine, wood stain, art and hobby supplies, etc.).

Time required

Two class periods, plus homework assignment.

Background information

One of the most effective means of reducing the risks associated with the use and disposal of household hazardous products is to use safer alternatives whenever possible. One of the easiest categories of household hazardous products to replace is household cleaners. Whether we realize it or not, our homes are filled with simple and safe products that are as effective as many of the modern household cleaners we have come to depend on. Many of these simple products are not

only as effective, but more economical as well. Some alternative cleaning products, like baking soda, lemon juice, and vinegar go back many years and are things our grandparents and great-grandparents used.

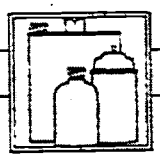
Other alternative products exist as a result of contemporary research aimed at the development of less volatile solvents to replace petro-chemicals. Water and plant-based paints and household cleaners, for example, are results of this research.

Unfortunately, there are few alternative substitutes for hazardous household products other than household cleaners. There are also several hazardous household products (motor oil and antifreeze, for example) which many of us cannot do without. The key to our use of products such as these is conservation. We can all help to reduce the potential damage of household hazardous products to our environment and our health by (1) purchasing only as much of a household hazardous product as we actually need; (2) using up products as intended; (3) giving away unused portions of products to others who can use them; and (4) reusing and recycling left-over or used portions of products whenever possible.

By using and supporting less toxic or non-toxic household products whenever they are available, we can make a difference. As consumers we have the power to determine what products are and are not accepted in the marketplace. By refusing to purchase products which threaten the safety of our environment and our health, we encourage manufacturers to replace these products with safer alternatives.

Consumers must be careful, however, in evaluating products which claim to be "environmentally friendly". Just because a product now contains vinegar doesn't necessarily mean that it is more "environmentally safe", since it may still contain other, more hazardous ingredients. Nor is such a product necessarily any more effective than plain old vinegar and water, even though it may come in a fancier package and cost twice as much. There has been little scientific research to date on the supposed "Green Products" which have recently made their way to the marketplace. And there is no established set of criteria on which claims of "environmentally friendly" are based.

Good estimates of the amount of household hazardous waste generated each year in MWRA sewer communities are not yet available. However, even rough estimates suggest that there is a substantial amount of household hazardous waste disposed anually and that actions by individuals to reduce this amount can



be very effective. For example, experts estimate that an average household anually disposes of 15 pounds of hazardous waste. This translates to an estimated 13 million pounds (6,525 tons) of household hazardous waste which are disposed of in the MWRA sewer service area each year. If only each of the 870,000 households in the MWRA sewer service area were to cut in half the amount of household hazardous waste that they currently generate, the amount of household hazardous waste disposed of in the MWRA sewer sevice area could be reduced by more than an estimated 6.5 million pounds (3,300 tons) per year.

Procedure

Please Note: Although this lesson is designed to stand on its own, it assumes that your students have some prior knowledge about:

(1) What is a household hazardous product and what makes its hazardous; (Lesson 7)

(2) How you can tell whether or not a product is hazardous; (Lesson 8) and

(3) What are some examples of household hazardous products. (Lesson 9)

Your students can gain this knowledge if they do Lessons 7-9 before they do this one or if you lead a discussion of these topics as an introduction to this lesson. The student pages that go along with Lessons 7-9 should give you enough information to be able to lead an introductory discussion.

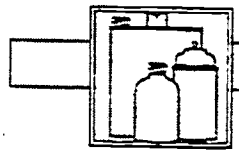
Day 1:

If your students have already done Lessons 7-9:

1. Ask your students to name some commonly used household hazardous products. List them on the board.

2. Hand out scissors, magazines and newspapers. Ask students to cut out advertisements for household hazardous products and to glue them, collage style, on a large sheet of paper. Hang the collage where it is easy to see. Ask your students to discuss the role which advertising plays in substantiating our belief that household hazardous products are a necessary part of our daily lives.

3. Advance to number 4 below.



If your students have not already done Lessons 7-9:

1. Lead a discussion with your students which centers on topics 1-3 listed above. (1) What is a household hazardous product and what makes its hazardous; (2) How you can tell whether or not a product is hazardous; and (3) What are some examples of household hazardous products.

2. When you get to topic (3), we suggest the following:

   Since your students have never studied this topic before, they may not have a very good idea of which products in their home are hazardous and which are not. The best way to identify whether or not a product is hazardous is to read the label. Therefore, we suggest that you actually read aloud the warnings, caution statements, first aid instructions, etc., on the labels of some real examples of hazardous products that students frequently use.

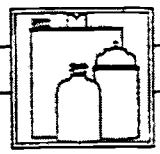
3. Advance to number 4 below.

4. Distribute "Safer Alternatives for Hazardous Household Cleaners." Read aloud a few of the alternatives it suggests. If possible, display examples of the substitute products as you read about their uses.

   Optional: Demonstrate the effectiveness of one of the alternatives listed. Example: Show how well vinegar and water works to clean a student's glasses.

5. Distribute "Alternatives Assignment Sheet." Ask each students to try out one of the alternatives as homework and to use the questions on the "Alternatives Assignment Sheet" to help him/her evaluate it.

   Optional: Use this activity as an opportunity to introduce the scientific method to your students. Ask your students to design a controlled experiment which would allow them to test out how well the suggested alternatives really work.



Day 2:

1. Ask students to make a presentation of the results of their evaluations or experiments to the class. (Evaluations, experiments and presentations may be done singularly or in groups).

Sample discussion questions

1. What are some reasons that people choose to use household hazardous products? (They are effective; they are convenient; they come in nice containers; we have been taught by commercials that those products which promise us more time, less effort and "more shine" are an essential part of our life, etc.).

2. Which products are more expensive-- the commercially sold "convenience" cleaners, which contain potentially hazardous ingredients, or the safer alternative cleaning products like vinegar and baking soda?

3. Are any of the suggested alternatives used in your students' homes already? How many of your students think that their family would be willing to stop purchasing commercially sold household cleaners and use alternatives instead?

4. Why would it would be good for a family to eliminate or reduce their use of hazardous products in the home? (Refer to "Guide to Hazardous Products in Your Home" to learn more about the problems associated with the use and disposal of household hazardous products).

5. How effective are the suggested alternative cleaners? Are the suggested alternatives easily found in the home or in the grocery store? Are the alternatives convenient?

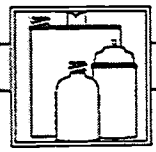
6. Can your students think of some other alternatives to hazardous household cleaners, in addition to the ones described in "Safer Alternatives for Hazardous Household Cleaners" ?

Additional activities

1. Ask your students to create advertisements for the safer alternatives which were the subjects of their evaluations or experiments. Let them choose between making a television or radio commercial or a magazine ad. Ask them to share their commercials or advertisements with the class.

2. Ask your students to create bumper stickers or posters persuading the public to reduce its use of household hazardous products.

Parts of this lesson plan were adapted from *Toxics in My Home? You Bet!- Curriculum on Household Toxics for Grades 7-8,"* Golden Empire Health Planning Center, P.O. Box 162997, Sacramento, California 95816, copyright 1984.



Safer Alternatives for Hazardous Household Cleaners

One of the most effective means of reducing the risks associated with household hazardous products is to use safer alternatives whenever possible. One of the easiest categories of household hazardous products to replace with alternatives is household cleaners. Whether we realize it or not, our homes are filled with simple and safe products that are as effective as many of the modern household cleaners we have come to depend on. Many of these simple products are not only as effective, but more economical as well. Some alternative products, like baking soda, lemon juice, and vinegar go back many years and are things our grandparents and great-grandparents used.

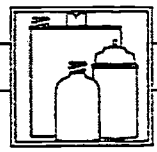
With just a few simple items that are probably already in your kitchen cabinet, you can make your own "alternative cleaning kit." You can use this kit to follow the alternative cleaning and polishing recipes listed on the following pages.

As with modern household cleaners, these recipes may not work every time. Before turning to a hazardous household cleaner, however, it's at least worth giving the appropriate safer alternative recipe a try.

Safer Alternatives to Hazardarous Household Cleaners

Alternative Cleaning Kit:
baking soda - salt - vinegar - lemon juice - vegetable oil - toothpaste - club soda

PRODUCT	*ALTERNATIVES*
All-Purpose Cleaner	Vinegar and salt solution.
	Four tbs. baking soda to 1 qt. warm water.
Glass Cleaner	Equal parts vinegar and warm water.
Decal Remover	Rub with sponge or cloth saturated with vinegar.
Tub & Tile Cleaner	Sprinkle baking soda, rub with damp cloth, rinse thoroughly.
	Vinegar and water solution.
	Full strength vinegar followed by baking soda and water solution.
Floor Cleaner	Mop with vinegar and water solution, polish with club soda.
Refrigerator Deodorizer	Place an open box of fresh baking soda inside the refrigerator.
Silver Cleaner	Coat silver with toothpaste, run it under warm water, rub with a cloth to work toothpaste into a foam. Rinse with water, polish dry.
	Place a piece of aluminum foil in a pan, add 2-3" of water, 1 tsp. salt, 1 tsp. baking soda. Bring to boil, add silver. Making sure that water covers the silver pieces, boil silver for 2-3 minutes. Remove silver, rinse, dry with a soft cloth.
Mildew Remover	Vinegar and water solution.
Shoe Polish	Rub with lemon juice, buff with soft cloth.
Drain Cleaner	
Prevention:	Use a drain trap to catch food and hair.
	Collect cooking grease in a can.
	Pour boiling water down drain weekly.
To clear clog:	Plunger.
	Mechanical snake (manually pushes clog away).
	Pour 1/2 c. baking soda down drain, followed by1/2 c. vinegar. Cover drain, let sit for 15 min., flush with two qts. boiling water.



Safer Alternatives to Hazardous Household Cleaners

PRODUCT	*ALTERNATIVES*
Air Freshener	Boil cinnamon and cloves in water.
	Lay withering flower petals on a newspaper, sprinkle with powdered alum (found in the baking section of a grocery store) or orris root (found in a craft store). Allow the petals to dry. Mix dried petals with your choice of spices (cinnamon, nutmeg, allspice, cloves, etc.). Add a drop of a natural oil (rose, lilac, etc.- also found in craft store) and mix. Put mixture in baskets, jars or sachet bags and place around your home.
Furniture Polish	One part lemon juice to two parts olive oil or vegetable oil. Rub with soft, dry cloth.
Stain Remover	Soak stain with club soda before washing. (Wine, chocolate, blood, fruit juice)
Oven Cleaner	
Prevention:	Place sheet of aluminum foil underneath heating element to catch spills.
Cleaning:	Wet spill slightly and sprinkle with salt. Scrape away spill, wash with soap and water.

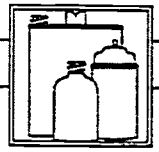
Sources:

The alternative products and recipes listed above were compiled from several sources, including the following:

***A Safer Home: Reducing Your Use of Hazardous Household Products,* by Carl Woestendiek, published by the Washington Toxics Coalition, 4516 University Way NE, Seattle, WA 98105.**

***Non-toxic Cleaners, by Jennie Goldberg,* published by the Washington Toxics Coalition, 4516 University Way NE, Seattle, WA 98105.**

***Guide to Hazardous Products Around the Home,* Missouri Household Hazardous Waste Project, 901 South National Avenue, Box 108, Springfield, MO 65804.**



Safer Alternatives to Hazardarous Household Cleaners

Name _____

Alternatives Assignment Sheet

Directions: Choose an alternative product or recipe from "Safer Alternatives for Hazardous Household Cleaners" and try it out to see how well it works. Does it work as well as its more hazardous counterpart? Is it as convenient? Record your results in the spaces below.

1. What is the name of the household hazardous product which the safer alternative is meant to replace (furniture polish, shoe polish, glass cleaner etc.)?

   What is the purpose of this household hazardous product?

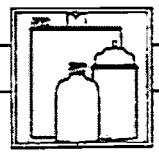
2. What is the safer alternative product/recipe? (Please describe.)

3. Does the safer alternative work as well as its more hazardous counterpart?

4. Is the safer alternative easily found in your home or in the grocery store?

5. Would you use this safer alternative in place of its more hazardous counterpart on a regular basis? Why or why not?

Lesson 11



Lesson 11 Home Safe! Board Game

Purpose:

To reinforce students' understanding of the impact of household hazardous products on our health and our environment and of the ways in which we can help to minimize that impact.

Activity in brief

Students reinforce facts and concepts learned in previous lessons through a board game available from MWRA.

Materials

The *Home Safe!* Game Kit (Available for loan from MWRA, call Meg Tabacsko at (617)242-7310). Each kit contains 5 games, which should be enough to accommodate a class size of 30 students. You can organize the games in any manner to suit your class, but we suggest at least two players per team and two teams per game. We also suggest a lead time of two weeks for reserving a game kit for your class.

Time required

This lesson requires one class period. Estimated playing time is thirty minutes.

Background

The *Home Safe!* Board Game was developed by the Missouri Household Hazardous Waste Project in cooperation with the Springfield, Missouri Public Schools. The rules of play for *Home Safe!* are very similar to Trivial Pursuit. Students are asked to correctly answer questions in four categories: Pesticides, Paints and Solvents, Household Cleaners and Automotive Products. Students win the game by collecting four colored discs which represent one correctly answered question in each category.

Procedure

1. Explain the rules of the game to your students (player directions are included in the game kit).

2. Play the board game *Home Safe!* to reinforce the concepts addressed in Lessons 7 through 10.

Glossary and Evaluation

GLOSSARY

Absorption: The process of taking something in. Toxic substances can be absorbed into the bloodstream through contact with skin tissue.

Active Ingredients: The chemicals which actually perform the intended function of a product. For example, the active ingredient in a pesticide is the ingredient which actually kills the pest.

Acute Effects: Health effects which occur very soon (immediately or up to two weeks) after exposure to a hazardous substance.

Aeration: The process of adding a gas (air) to a liquid (wastewater). In secondary treatment air is added to the wastewater to stimulate the growth of beneficial bacteria which consume most of the remaining waste material.

Alternative: Something that can be chosen instead of something else. For example, toothpaste is an alternative to commercially-sold silver polish which contains hazardous ingredients.

Bacteria: Any of a number of single-celled microorganisms occurring in a wide variety of forms, existing either as free-living organisms or as parasites, and having a wide range of biochemical, often pathogenic, properties.

Bar Screens: The first step in the wastewater treatment process. The bars are between 3/4 of an inch and 3 inches apart. Wastewater is allowed to pass through the bars, but large solid objects such as rocks, cans, plastic bags and sticks are stopped.

Bio-magnification: The process by which some chemicals become more and more concentrated as they work their way from one organism to another up the food chain.

Boston Harbor: The ocean outlet for the Charles, Mystic and Neponset Rivers which serves as the receiving water for the discharge of MWRA wastewater and is often described as "The Dirtiest Harbor in America".

Cholera: An acute, often fatal, infectious epidemic disease caused by a microorganism.

Chronic Effects: Health effects which are the result of repeated exposure to a hazardous substance over a long period of time.

Combined Sewer: A sewer intended to carry both sanitary/industrial wastewater and storm water.

Combined Sewer Overflow (CSO): The excess wastewater from combined sewers that is released directly into receiving waters in order to avoid back-ups into populated areas.

Contaminant: A substance that causes another substance to become impure by contact or mixture.

Corrosive: Able to eat away materials and living tissue by chemical action.

Dewatering: The process by which water is removed from a substance, such as sludge.

Digestion: The process by which organisms are used to break down sludge into methane gas, carbon dioxide, solid organic by-product and water. (**Aerobic Digestion** takes place in the presence of oxygen and **Anaerobic Digestion** takes place in the absence of oxygen.)

Disinfection: The final step in the wastewater treatment process, when chlorine or sodium hypochlorite is added to the wastewater to kill disease-causing organisms before discharge.

Effluent: The "cleaned" wastewater or final liquid which flows out of a treatment plant.

Environment: All the objects, organisms and conditions which surround and affect the plants and animals of an area, such as the marine environment of Boston Harbor.

Explosive: Able to react with air, water or other substances and result in explosions and the generation of toxic fumes.

Fertilizer: Any of a large number of natural and synthetic materials, including manure and nitrogen, phosphorus and potassium compounds spread on or worked into soil to increase its fertility.

Flammable: Able to undergo spontaneous combustion at relatively low temperature, thereby presenting a significant fire hazard.

Grit Chamber: A tank where the flow of wastewater is slowed allowing heavy solid objects, such as pebbles, sand, coffee grounds and coins, which passed through the bar screens, to sink to the bottom.

Grit and Screenings: The solid material collected by the bar screens and grit chambers.

Hazardous: Dangerous. A hazardous substance is one which is likely to cause harm to the environment or human health because it is toxic, corrosive, flammable or explosive.
Household Hazardous Product: A household product which can threaten or harm

Household Hazardous Product: A household product which can threaten or harm human health or the environment when used or disposed improperly.

Household Hazardous Waste: Unused portions of household hazardous products that somebody no longer wants or has a use for.

Incineration: The process of destroying or reducing something through burning.

Inert Ingredients: Chemicals which carry the active ingredients of a product in a form which makes them easy to apply or use. Although **inert** means "inactive" to the intended function of a product, it does not necessarily mean "harmless" to humans or the environment.

Infiltration: Groundwater which enters sewers through cracks and faulty joints in pipes and manholes.

Inflow: Surface water, usually from storm runoff, which enters sewers through improper direct connections such as roof drains, storm drains and sump pumps.

I/I: The term given to the two sources of extra water in a sewer system (infiltration and inflow).

Influent: Wastewater as it flows into a treatment plant.

Ingestion: Taking something into the digestive tract through swallowing. Toxic substances can be ingested by eating or drinking something which contains them or is contaminated by them.

Inhalation: Taking in by breathing. When inhaled, substances enter the lungs and go directly to the bloodstream.

Inorganic: Refers to material made up of non-living matter, such as minerals or salts.

Land Application: The spreading of wastewater sludge on land for the purposes of improving soil structure and for supplying nutrients important to plant growth.

Landfill: A disposal site for solid waste, such as grit and screenings, in which the material is packed and covered with earth.

Leach: To dissolve out by the action of percolating water.

Leachate: A solution resulting from leaching.

Massachusetts Water Resources Authority (MWRA): An independent state agency created by an act of the Massachusetts Legislature in December, 1984. The MWRA provides water and sewer services to 60 cities and towns.

Microorganisms: Microscopic plants or animals, invisible or barely visible to the naked eye. Examples are algae, bacteria, fungi, protozoa and viruses.

Midden: A heap of animal excrement or refuse, especially of a primitive habitation.

Organic: Refers to material which contains carbon. This includes all plants and animals, living or dead, and their by-products. Petroleum and its by-products, for example, are organic substances.

Pathogens: Disease causing microorganisms, commonly bacteria, which get into wastewater through human wastes and other sources.

Pelletizing: A process which evaporates moisture from sludge to form small, solid particles, called pellets, for use as fertilizer.

Pollution: The contamination of soil, water or the atmosphere by the discharge of harmful substances.

Primary Treatment: The first stage of wastewater treatment, after screening and grit removal, using a physical process in which material is allowed to settle out of the wastewater.

Raw Sewage: Untreated wastewater.

Receiving Waters: A body of water into which effluent is discharged.

Recycle: To extract useful material from what was considered waste.

Residuals: The term commonly given to the "solids" removed from wastewater.

Runoff: Rainfall or other water that is not absorbed into the soil and drains off the street or land.

Sanitary Sewer (or separate sewer): A sewer intended to carry only sanitary wastewater from homes, businesses, schools, etc.

Scum: The floatable material in wastewater made up mainly of fats, oil, grease, styrofoam and small bits of plastic which is skimmed off in the treatment process.

Secondary Treatment: The second stage of wastewater treatment, using a biological process in which bacteria consume organic matter, then settle out as sludge.

Sedimentation: The process by which solid material settles out of a liquid. Sludge settles out of wastewater in sedimentation tanks.

Sewage (or wastewater): The used water and added waste of a community which is carried away by drains and sewers.

Sewerage: A system of sewers. The removal of waste materials by means of a sewer system.

Sludge: The solid waste material which settles out in the wastewater treatment process.

Soil Conditioner: Material added to the soil to improve soil structure, to hold plant nutrients and to provide favorable conditions for useful earthworms, bacteria and fungi.

Soluble: Capable of being dissolved.

Solvent: A substance (usually liquid) which is capable of dissolving or dispersing one or more other substances.

Storm Sewer: A sewer intended to carry only stormwater, surface runoff, street wash water and drainage.

Toxic: Capable of causing illness, injury or death through ingestion, inhalation or absorption.

Waste: Material that somebody no longer wants or has a use for.

Wastewater (or sewage): The used water and added waste of a community which is carried away by drains and sewers.

Suggested Activities

Conduct a spelling bee using words from the glossary.

Have the students select five words from the glossary and cite either an antonym or a synonym for each.

Have the students read current newspaper articles searching for words from the glossary.

DOWN THE DRAIN EVALUATION FORM

NAME:_____

SUBJECT(S):_____ GRADE LEVEL_____

SCHOOL:_____

SCHOOL
ADDRESS:_____
(street) (city) (state) (zip code)

SCHOOL
TELEPHONE NUMBER:_____

****

Which lessons did you use?

1 2 3 4 5 6 7 8 9 10 11

Please fill in the appropriate Lesson # you are referring to and rate each using the following scale:

1 = strongly disagree **2 = disagree** **3 = somewhat agree**
4 = agree **5 = strongly agree**

	Less.#___ worst to best	Less.#___	Less.#___	Less.#___
1. Instructions were clear	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
2. Information was clear and concise	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3. Easily adapted to classroom	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
4. Appropriate for grade level	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
5. Held students' interest	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
6. I will use this lesson again	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
7. I will recommend this lesson to others	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

Please use the other side of this form for comments and suggestions.

COMMENTS AND SUGGESTIONS

Please check the appropriate line(s) if you think these suggestions would improve DOWN THE DRAIN or help you bring wastewater education into your school program.

____ Lessons on other topics
(please expand)

____ More background and training for teachers
(please expand)

____ Kits of demonstration material
(please specify which materials were difficult to find)

____Better graphics
(please expand)

____Better organization and format for lessons
(please specify which lessons)

____Other comments and suggestions

Please return evaluation to: Meg Tabacsko
MWRA - Sewerage Division
Charlestown Navy Yard
Boston, Massachusetts 02129

S6016004

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(over)